STANDARDS DEVELOPMENT BRANCH OMOE
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CHARACTERIZATION OF HAULED LIQUID INDUSTRIAL WASTES IN ONTARIO

PART 1

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M68
1981

Ontario
Ministry of the Environment

The Honourable
Keith C. Norton, Q.C.,
Minister

Gérard J. M. Raymond
Deputy Minister

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CHARACTERIZATION OF HAULED LIQUID INDUSTRIAL WASTES IN ONTARIO

Chester.
Please accept
my first copy
with compliments
and respect of
Moselhy
May. 1982.

PART I

PREPARED BY: Dr. M.M. Moselhy
Laboratory Services Branch

In co-operation with Laboratory Services Branch Sections and Waste Management Branch, M.O.E.

JUNE 1981

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Water Quality Section
Microbiology Section
Pesticides Section
Inorganic Trace Contaminants Section and
Organic Trace Contaminants Section.

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9. MOE classification guideline for hauled liquid industrial waste and Ontario's waybill form.

* Available upon request from I.T.C. Section, Laboratory Services Branch, Ministry of the Environment.

1. ABSTRACT

The cumulative environmental problems created by liquid industrial wastes combined with public and government awareness of the mounting hazards associated with them have come to a point where urgent action is required. The issues ensuing from the generation, transfer and ultimate disposal of such wastes have been felt and acted upon by the Ontario Government for several years. The national awareness of the hazards associated with the Niagara River/Love Canal and other contaminated areas in the U.S. has escalated public concern to the point where immediate action on total management of industrial wastes is needed.

The Ontario Ministry of the Environment has responded and opted to act on several fronts. Among these directions are the regulation of flow of industrial wastes through the waybill system, updating the waste classification guidelines on the basis of chemical characterization of various types of liquid wastes, and by planning waste disposal-treatment plants.

The present report details the analytical information on the chemical and biological agents that were characterized in a selection of liquid industrial waste samples. An attempt has been made to briefly describe the methods used for analyses, and the obtained data have been correlated to the anticipated waste classification. Brief comments have also been made on the effectiveness of the present Waste Classification Guideline, and the need to establish a system for the analysis of such materials in the Laboratory Services Branch.

2. INTRODUCTION

"The growing and pressing problems of disposing of liquid industrial wastes have become Province-wide problems, not local problems. They must be solved on a provincial, rather than a parochial scale. An increasingly important aspect of (my) Ministry's programs continues to be the improvement of waste management practices... including the recycling and conservation of non-renewable resources of materials and energy, and the safe disposal of our domestic and industrial wastes.

It is essential that we have safe, well planned, well located treatment and disposal facilities to serve the best interest of all citizens of Ontario."

These as just a few phrases from the Hon. Dr. H. Parrott's speech to the Parliamentary Committee in June, 1980.

Mr. G. Scott, then MOE's Deputy Minister, also commented (1980) on this subject and concluded that there is no easy solution for the pressing problems associated with industrial wastes, and he stressed that the only way to preserve the total environment and at the same time not curb advances in industrial activities is to have a "Total Management" of industrial wastes. Considering this, if the objective is to design a total management procedure for the handling and safe disposal of industrial wastes, a logical question would be: what is the nature and composition of industrial wastes generated in Ontario?

This same question was the cornerstone in the creation of the Characterization of Hauled Liquid Industrial Wastes (CHLIW) project in Ontario.

Part (1) in this report includes the main body of the CHLIW report based on the obtained analytical information.

Part (2) contains the analytical data obtained by the following Laboratory Services Branch Sections:

Water Quality, Microbiology, Pesticides, Inorganic Trace Contaminants and Organic Trace Contaminants.

In response to Mr. W. Bidell's memorandum of August 20, 1980 (attached) to Regional Directors, the project was initiated by the Deputy Minister to provide better characterization of industrial waste types described in the Waybill Classification Guideline (1978). The program called for collecting one sample of each type of industrial waste generated in each region. It was also decided that industries be chosen which are both large and small and have significant waste volume and export waste to the U.S.A. or use landfill sites. In fact, the characterization of the liquid industrial waste project is a natural continuation of the M.O.E.'s efforts in regulating the flow of wastes. Among these efforts which aimed at the protection of the total environment are the activities created by the Hazardous Substances Committee in the seventies and its successors in the eighties, a large number of "ad hoc" projects and legal cases generated by various Regional and Branch Offices, studies related to dredging and disposal of wastes in various water bodies, and monitoring of various chemical agents in the Great Lakes.

Some activities were more specifically oriented to industrial wastes:

i) test trial of incineration of organic liquid wastes at the St. Lawrence Cement Co.

ii) incineration of liquid wastes of Tricil-Mississauga and Sarnia

iii) studies of the impact of incineration of industrial wastes on air quality

iv) the expansion in the MOE central Laboratory's diagnostic capabilities to cope with the increasing demands to identify and determine minor and major components of a wide variety of organic and inorganic chemical agents related to industrial wastes classification and treatment.

Past experience has shown that temporary remedies are not effective and the operation of waste disposal plants seems to be the practical solution for safe containment of such wastes. The desire to continue and expand industrial prosperity in Ontario will need to be accompanied by a commitment to develop a reasonable solution for safe disposal of the generated wastes. The best available technology at present has generally pointed towards the option of waste disposal plants constructed to ensure secure and tight control of movement of wastes. The European experience in this area tends to support such an option.

3. WAYBILL SYSTEM

Ontario's Waybill system officially came into effect on April 1, 1977, through Ontario Regulation 926/76 for "Transfers of Liquid Industrial Wastes", made under Part V of the Environmental Protection Act, 1971. The primary purpose of this legislation was to track the transfer/disposal of hauled liquid industrial waste from the generator through to the receiver of these wastes. A secondary, but equally important purpose was to provide statistical information on types and quantities of liquid wastes generated and received. This is very useful for both abatement and monitoring the changing patterns of waste handling.

The initial waybill format required the waste generator to identify the waste material being transferred by entering a written description, consisting of a few words, on the Waybill form.

It soon became evident that these descriptions were inadequate since they were often non-specific and were not compatible with a computerized system. In an attempt to rectify this problem, a new waybill format and classification guideline were introduced by the end of 1978 to be put into effect no later than February 1, 1979. The

guideline was prepared to assist generators and contained examples of waste descriptions, formerly used, which could now be identified as a three digit waste code. This revised system has operated fairly effectively, although it is now recognized that more detailed waste classification is required.

4. OBJECTIVES OF THE CHLIW STUDY

The main objectives of CHLIW study were to characterize a selection of industrial wastes and to identify the composition of each collected sample relative to its classification in the waybill system. The laboratory also attempted to determine the most meaningful chemical/biological parameters to achieve these objectives with minimal analytical cost and time. The detected chemical and biological agents would be assessed relative to their toxicity, mutagenicity and carcinogenicity. The waybill system has produced statistical data on the types and quantities of hauled liquid industrial wastes which are generated and/or received in Ontario. However, continuous technical advances in chemical processing and the large number of new chemical compounds annually introduced in industry have made it increasingly difficult to properly classify many of the wastes by the present system. Only through a chemical characterization of the waste can one point out the inadequacies of the existing classification system, determine which classes are improperly identified, and determine other significant contaminants that could be overlooked in these materials.

Since sampling and analyses of all wastes being transported in Ontario exceed the scale of the present program, MOE Regional Staff were requested to obtain at least one sample of each waste type. This would provide a cross section of liquid waste that is reasonably representative of all wastes generated in the province. For this purpose, over one hundred samples were collected from various sources representing most of the waste types generated in Ontario. A breakdown of these samples including source and classification type is also presented in this report.

5. SAMPLING OF INDUSTRIAL WASTES

The most important factor in attacking an industrial waste problem is a complete knowledge of the character of the waste to be treated or disposed of. A cursory glance at a particular waste will not enable anyone to solve the problem satisfactorily. Factors such as acidity, alkalinity, chemical constituents, presence of toxic materials or elements, and so on cannot be determined macroscopically. The first step then, after an industrial waste problem has arisen, is to determine the nature and character of the wastes. For this purpose, the following protocol is suggested:

1. Develop a specific objective.
2. Review all available reports related to the study.
3. Do not assume a previous occurrence will necessarily be duplicated.
4. Collect all available information on the sources of wastes.
5. Select sampling sites.
6. Select the appropriate sampling devices.
7. Ensure that sampling covers all phases of production.
8. Repeat sampling if waste discharges vary drastically.
9. Obtain agreement with the laboratory on the number of samples required for specified analyses.
10. Review the analytical data produced to detect any need for revision of the original plan.
11. Consider all possible interpretations of data including recommendations.

Before any analyses can be made on industrial wastes, it is necessary to obtain accurate samples of the wastes. If the waste to be treated is uncommon or its main characteristics are not generally known, or where variations in waste composition occur from plant to plant, the samples taken must be characteristic of the particular waste.

They must be taken in a manner that brings to the analyst all compounds which may cause pollution, in the proportions in which they are found in the actual waste.

If the wastes are to be collected and combined in holding tanks and/or introduced into incinerators, then it is important to obtain representative samples of the combined flow, with rate readings, and the quantity of waste.

In industrial plants where a variety of operations is carried out, several classes of wastes may be discharged during the working day. In this case, it is important to properly collect samples of each type of waste separately, in addition to samples collected from waste storage tanks. Such an approach might compensate for the misrepresentation of samples taken from waste holding tanks, and provides a means of identifying some of the processes that might take place when a variety of organic and inorganic agents are mixed together under uncontrolled conditions.

If the wastes are collected and stored in drums, proper sampling of a multi-layer waste should assure the proper presentation of the sample taken relative to the composition of the waste. Since vigorous shaking of the waste in storage tanks and drums is obviously impractical, a simple device in the form of a 1 - 2 inch diameter glass tube can be inserted cautiously into the drum thus trapping a "thickness" from each layer of the multiphase waste. An adequate stopper tied by a string which passes through the tube can then be pulled by the sampler to close the bottom end of the glass tube. The content of the tube sampler can then be transferred to sample containers. These samples should be kept in clean glass bottles. Samples which require inorganic analyses should not be covered with metal or metal-lined caps. On the other hand, samples containing organic solvents and requiring identification of organic compounds should be covered with metal-lined bottle caps.

Since acidity, alkalinity and pH are among the tests to be conducted on the waste material, sample preservation by the addition of acid should be avoided. The possible loss of traces of metals by vessel absorption will generally be insignificant for most wastes. Samples which require microbiological testing not only should be preserved, but also should be delivered to the laboratory within a time limit as set by the analyst. Simple common-sense should be considered during the sampling process. For example, solids, semi-solids or liquids which solidify at ambient temperatures should not be stored in narrow-necked bottles. It is important for the analyst to corroborate field physical inspection of samples to describe their colour, appearance, smell and/or physical condition. Wastes which contain regulated toxic and hazardous materials should be marked on the bottle and fully described in the sample submission form together with all other pertinent data. Careful packing and safe shipment of samples should be ascertained with the shipping boxes clearly marked.

6. CHLIW SAMPLES AND SOURCES

In this study, Regional Industrial Abatement Staff have approached a selection of large and small industries to obtain samples of liquid wastes which were destined to be hauled away for subsequent disposal. These samples were withdrawn from either storage tanks or drums on the property of the generator. Duplicate samples were collected where appropriate and preserved if necessary. Samples which required organic and inorganic analyses were not preserved. No unusual sampling technique was employed. The following is a list of the selected industries and the expected waste type according to the MOE "Classification Guideline for Hauled Liquid Industrial Wastes (Dec. 1978)".

It should be borne in mind, however, that it was not the objective of the study to cover all industries in Ontario which produce classified or non-classified wastes, but rather to select a group of sources that generate wastes described in the Waste Classification Guideline. Liquid industrial wastes that have been mixed collectively in holding tanks for storage, pre-treatment, recovery, and/or prior to their disposal were not sampled. Furthermore, liquid industrial waste materials that have already been disposed of in land-fill sites were not part of the sampling scheme since the objective of the study was to get a better feeling of the nature of the produced wastes versus the M.O.E. classification.

The following table presents the distribution of samples relative to their classification code.

Number of samples submitted relative to each class type.

CHLIW STUDY - 1980

CLASSIFICATION	# SAMPLES
101	2
102	14
103	7
106	1
190	9
201	9
202	9
203	12
204	3
205	5
206	1
207	3
208	4
290	6
301	8
302	2
303	4
304	2
401	5
402	5
20 types	111 samples

CHLIW Samples: Classification vs L.S.B. number

SUBMITTED CLASSIFICATION	LSB DESIGNATION #	# SAMPLES
101	T41-18, T44-19	2
102	T35-27, T42-31, T43-6, 14, 15, 16, 17, 18, 19, 20, 21, 34, T44-11, 18	14
103	T41-3, 6, 16, T43-33, 83, T46-15, 16	7
106	T41-2	1
190	T37-14, T41-1, 4, 9, 19, T42-5, T43-31, 42, T4-24	9
201	T42-10, 37, T43-24, 30, T44-10, 12, 14, 15, T45-45	9
202	T42-32, 33, 34, 35, T43-1, 22, 23, 32, 39	9
203	T41-10, 13, 15, T42-25, 28, 39, T43-7, 11, 12, 25, 26, 36	12
204	T41-8, T43-28, 40	3
205	T41-11, T42-29, T43-3, 5, T44-17	5
206	T41-21	1
207	T41-12, 14, T43-10	3
208	T41-20, T42-4, T44-20, 21	4
290	T41-1, 7, 22, 23, T43-9, 13	6
301	T42-8, 30, T43-2, 27, 35, T44-8, 9, 16	8
302	T42-6, 27	2
303	T42-36, T43-37, 41, T48-20	4
304	T41-17, T42-38	2
401	T42-26, T43-38, T44-7, T45-46, T46-1	5
402	T41-5, T42-7, 9, T43-4, 8	5
	Total	111

T35-27: Source: Breslube Waterloo ; Ind. Abat. Cambridge.
Caustic waste delivered to Breslube by A&A Waste haulers for fixation of their suldge.# 102.

T37-14: Canadian General Electric, Peterborough. Waste from drive system, spent acids and water-neutralized.
Mix of HF, HNO_3, H_2SO_4, HCl, acetic acids all neutralized.#190.

T41-1: Morrison Frozen Foods, Etobicoke. #290.

T41-2: International Harvester Truck Assembly Plant, Chatham.
Bondenite solution: phosphate, zinc, nickel, salts and nitrates.#106.

T41-3: Gulf and Western
Waste pickle acid up to 10% H_2SO_4.
Contains Fe, Ni, and Cr.(#103)

T41-4: Photoengravers - Rexdale
Ferric chloride waste from etching area.#190.

T41-5: Imperial Oil Ltd., Sarnia
Inert sludge #402.

T41-6: National Hardware - Sarnia
metal finishing #103.

T41-7: CIL Courtright - Sarnia
contains fluorosilicic acid - TNT #290.

T41-8: Ethyl Corporation - Sarnia
chlorinated solvents - heat transfer fluid up to 2% HCl #204.

T41-9: Cabot Carbon - Sarnia
Water contaminated with carbon black, some sand and stones.
May contain a small percentage of oil #190.

T41-10: Dow Chemical - Sarnia
organic solvent #203

T41-11: Dow Chemical - Sarnia
plastic resin #205.

T41-12: Dow Chemical - Sarnia
Glycols #207.

T41-13: Photoengravers - Toronto
solvents used to clean coloured ink - toluene, xylene, methanol, toluene #203.

T41-14: CGE - Landsdowne Toronto
waste water from resin manufacturing #207.

T41-15: Dupont - Durham Ajax
automotive paint manufacturing #203.

T41-16: CBS Records, 121 Leshest
Nickel plating waste and liquid sludge (top and bottom of tank) #103.

T41-17: UpJohn Limited
organic solvents, chloroform 70%, alc. 10%, hexane, toluene, acetic acid, acetone, vitamins, steroids, analgesics 20% possibly varsol #304.

T41-18: Surpass Chemical Limited
sulphuric acid #101.

T41-19: Fiberglass, Sarnia
Type 190, other inorganics

T41-20 Ethyl Corporation, Sarnia
Type 208, phenols, (phenol and water) $Al(OH)_3$, carbonates, sodium acetate, butylated phenols - see attachment

T41-21: CHINOOK, Sarnia
amines type 206

T41-22: Bulk Carrier, Sarnia
Type 290, other organics

T41-23: CIL Courtright, Sarnia
type 290, other organics - see attachment

T42-4: Ashland Chemicals Limited, Peel
phenols, solvents, 208

T42-5: Stelco, Burlington
spent lime from steel pickling operation with some ferrous chloride, type 190

T42-6: Ciba Geigy, Plattsville
pesticide wastes, type 302

T42-7: Square "D" of Canada Limited, Stratford
may contain cyanide
inert sludge classification 402 (cyanide 16 ppm)

T42-8: Westinghouse - London
paints - type 301

T42-9: IBM, Don Mills Road
pebble deburring of steel parts
inert sludge type 402

T42-10: Kolmar, Barrie
wash water from cosmetic vents Code 201 90% water, 10% fatty acids, esters, alcohols/glycols amines, petroleum by-products, fats/waxes, iron-oxide pigments, talcs-silicates, titanium oxide, inorganic salts.

T42-25 CPW - Vespra Twp. (Barrie)
solvent storage tanks code 203 (mixed solvents mainly from paints manufacturing). The material is shipped to Quebec for incineration.

T42-26 Primo Importing - Weston
grease and meat particles and floor flushing water. Type 401

T42-27 Chemagro - Concord - Vaughan Twp.
Pesticides manufacturing: Monestan 25, Dyrene 50, Atrazine 80, Disyston LC, Spotton P.O, Negawon P.O, Vitavax 200. Type 302.

T42-28 CIL Concord
bad paint, lab waste, solvents, minerals, spirits, xylene, excess paint. Type 203

T42-29 CIL Concord
Xylene waste type 205

T42-30 CIL Concord
95% water, dirty latex water from washing up operations, type 301

T42-31 Courtaulds Canada Ltd. - Cornwall
viscose - alkali - cellulose solution (Jelloid) caustic, the material is sometimes lipid or liquid depending on the reason for it being off specification, type 102.

T42-32 A-1 Sanitation - Burlington
From truck DK3-286 - reported as oil waste #202.

T42-33 A-1 Sanitation - Burlington
From north underground tank. Oil waste #202.

T42-34 A-1 Sanitation - Burlington
From south underground tank. Oil waste #202.

T42-35 A-1 Sanitation - Burlington
From middle underground tank, Wood treatment solution (As, Cr, Cu), type #202.

T42-36 Windsor Barrel - Windsor
Drum and final disposal waste. Caustic soda type 303.

T42-37 National Auto Rad. Windsor
Final disposal tank, type 201

T42-38 Whitehall Lab, Missisauga
Waste water sump: possibly ASA, corn starch sterotex, lactose, petroleum, shark liver oil, bees wax, cocoa butter #304.

T42-39 Chrysler Canada, Windsor
organic solvents, type 203

T43-1 Ford's WTP, Windsor
Waste oil for reclamation, type 202

T43-2 Allen Ind., Hamilton
Paint sludge #301.

T43-3 Allen Ind., Hamilton
Plastisol #205.

T43-4 Westinghouse Canada, Cobourg
Lime neutralized HF, type 402

T43-5 Borg-Warner Chemicals, Cobourg
ABS resin oversize, type 205

T43-6 Columbia Finishing Mills, Cornwall
Caustic solution from dye plant, Caustic. #102.

T43-7 Columbia Finishing Mills, Cornwall
Lacquer (Toluene,IRA, Acetone, Ethyl acetate, peroxy/
in lacquer #203.

T43-8 Pellon Chemotextiles Ltd., Cornwall
Latex sludge #402.

T43-9 Rohm and Haas Ltd., Morrisburg
Oil and acryloid waste from toluene still #290.

T43-10 Iroquois Chemicals Ltd., Cornwall
Sample contains toluene,propylene and other glycols and
maleic anhydride #207.

T43-11 Iroquois Chemicals Ltd., Cornwall
Methanol, toluene, MEK-MIBK #203.

T43-12 Modern Industries Ltd., Cornwall
Mixture of MEK, toluene, THF, IPA, hexane, varsol #203.

T43-13 Ford Motor Company of Canada, Oakville
Ontario Truck plant "E" coat, pereate waste tank.#290.

T43-14 CPW-Vespra Twp.
Douglas Aircraft, type 102

T43-15 CPW-Vespra: Long Manufacturing, type 102

T43-16 CPW-Vespra-General Motors, type 102

T43-17 CPW-Vespra-Alcan - Kingston, type 102

T43-18 CPW-Vespra-Long Manufacturing, type 102

T43-19 CPW-Vespra-Douglas Aircraft, type 102

T43-20 CPW-Vespra-General Electric, Peterborough
102 + PCB

T43-21 CPW-Vespra-Bulk load to Breslube, type 102 + PCB

T43-22 CPW-Vespra-Budd Automative to Breslube, type 202

T43-23 CPW-Vespra-tank #6 oils to Breslube, type 202

T43-24 Midland Industries - Midland
Waste oily water from machine shop, type 201

T43-25 Spectator - Hamilton - Wentworth
Blanket wash-organic solvents disposed #203.

T43-26 Blanket wash-organic solvents disposed #203.

T43-27 Waste - printing ink #301

T43-28 American Can - Hamilton-Wentworth
American Can silk cleaning solvent (perchloroethylene, isopropyl alcohol, cellosolve, hexane, toluene, MEK, MIBK, xylene) #204.

T43-30 Badische Liquid Ind. Waste, Arnprior (Pembroke)
Nylon plant spin finish #201

T43-31 Boeing Liquid Ind. Waste, Pembroke
paint stripper and water #190

T43-32 Plant National - York
Waste oil and solvents from barrel cleaning plant #202

T43-33 MOT Industries - Hamilton
chrome waste - #103

T43-34 Stanton Pipe - Hamilton
Cupola scrubber water #102.

T43-35 Rolph-Clark-Stone Packaging-Smith's Falls
Representative sample of various inks used diluted with alcohol. May contain ethyl acetate and Nitro cel.
type 301

T43-36 Bell Northern, RMOC, Ottawa
Microstrap, type 203
Corrosive material, clear colorless liquid, sharp aromatic odour
Chlorinated solvents. See attachment for WARNING AND TOXICITY - HAZARD.

T43-37 Andrew Jergens Ltd., Perth Ontario (Ottawa)
Acidulated foots tank, type #303 or 401

T43-38 Leaf Monarch - Windsor
Leaf Monarch waste disposal tanks #401

T43-39 Aeroquip Canada Ltd., Perth Ontario
Waste oil storage drum #202

T43-40 Aeroquip Canada Ltd., Perth, Ontario
Liquid waste storage tank #204 said to contain toluene, MEK, kerosene and water

T43-41 Andrew Jergens Ltd., Perth, Ontario
Sanitary waste grease separator-refining area. Waste is from tallow and soap refining process #303 or 401

T43-42 Eldorado Nuclear - Port Hope
Raffinate, RADIOACTIVE #190.

T43-83 Canadian Cylinder - Brant County
Heavy metals - Neutralized waste #103.

T44-7 Standard Paper Box Ltd., Belleville
Corn starch adhesive - wash down, type 401

T44-8 Water Based Printing Ink, Aqua Phox Inks, type 301

T44-9 Mobil Chemicals Ltd., Belleville,
Inks and solvents, type 301-203-202

T44-10 CONWIRCO Inc., Belleville
Oily wash solution used in the wire drawing industry, copper and aluminum #201.

T44-11 Deloro Stellite Canada, Ltd., Belleville
Caustic cleaver (dilute Magnus 614) used for cleaning motor parts, type 102

T44-12 Lubricants and cutting oils - maching shop wastes, type 201
Note: 1) a large variety of metals are handled
2) is this waste acceptable for road oiling?

T44-14 Northern TELECOM - Kingston,
5% water soluble lubricant oil, type 201

T44-15 Dupont Canada, Kingston
Spin finish sludge, Code Dupk 081E, type 201

T44-16 Dupont Canada, Kingston
Tire yarn tint solution
Tricil Dupk 041K, type 301

T44-17 Tricil, Kingston
50% nylon salt solution
Tricil 041B, type 205

T44-18 Alcan Canada, Kingston Works
Caustic, type #102

T44-19 Tricil, Kingston
85% formic acid, Tricil Dupk 150C, type #101, corrosive

T44-20 Dupont Canada - Kingston.
DupK 041J, type 208

T44-21 DupK 011F, type 208, corrosive

T45-45 Warren Whitely Ltd., Belleville.
Truck wash waste #201
* 1) can oil be used for road oiling?
2) can water be discharged to San Sewer?

T45-46 Standard Paper Box Ltd., Belleville, G. Skalin
Corn starch adhesive - wash down adhesive used in corrugated cardboard, type 401

T46-1 Corby Distillers Ltd., Belleville.
Rye mash syrup shop, type 401

T46-15 DOFASCO, Hamilton
Sodium Dichromate #103.

T46-16 Chromic Acid #103.

T48-20 Workwear Corp. of Canada Ltd., Belleville
Laundry waste, type 303

T4 -24 Boeing Canada, Pembroke
paint stripper #190.

7. SAMPLE HANDLING IN THE LABORATORY BRANCH

Since the program involved all sections of the Laboratory Services Branch, meetings were held between Sections Managers and the Waste Management Branch representatives to discuss the setting of priorities, analytical parameters, and coordination of LSB action. The total number of samples received by the Laboratory Branch amounted to 111 samples representing 20 types of liquid wastes and required the attention of five LSB sections according to the following schedule:

Organic Trace Contaminants Section OTC:	69 samples
Inorganic Trace Contaminants Section ITC:	54 samples
Water Quality Section WQ:	34 samples
Pesticides Section PEST.	25 samples
Microbiology Section MICRO.	5 samples

In the developed action plan, the Organic Trace Contaminants Section would provide classification and identification of organic compounds in the samples using Infrared Spectroscopy, Gas Chromatography, and Mass Spectroscopy if required.

The Inorganic Trace Contaminants Section would provide analytical data on heavy metals, mercury, arsenic, and cyanide as required. The Water Quality Section would provide analytical data such as pH, alkalinity, acidity, fluorides, chlorides, phosphates, nitrates, and sulfates in selected samples.

The Pesticides Section would provide data on PCB's, pentachlorophenol, specified pesticides, and herbicides as required. The Microbiology Section would provide data on total coliforms, Fecal coliforms, Escherichia Coli, Fecal Streptoccoci, Staphylococci, Pseudomonas Hydrophila, Salmonella species, and sulfate reducers.

Two of the samples were collected from Eldorado Nuclear in Port Hope and were marked as radioactive waste.

Since the Laboratory Branch does not usually handle such radioactive wastes, these two samples were submitted to the Radiation Laboratory of the Ministry of Labour for analysis. Preliminary tests showed the presence of low radiation levels (0.3 and 0.5 mrad/hr) and the Radiation Laboratory was requested to confirm the presence of radioactive ingredients by carrying out gamma-ray spectrometric scans of the two samples.

From the point of view of chemical analysis, such industrial waste materials are complex in nature and matrix composition. The presence of a large number of organic compounds does not imply the absence of heavy metals or the remote possibility of other toxic and hazardous substances being present. In fact, of the samples analyzed by the Pesticides Section, the highest PCB value obtained (25 ppm PCB) was found in a sample which originally did not specifically require the attention of the above section. Similar cases of the presence of one chemical or biological agent in the presence of another cannot be ruled out. This might suggest that a close look is needed at the actual chemical composition of such wastes prior to their mixing for incineration, pretreatment or ultimate disposal, and that the waste classification guidelines may need to be tightened.

The complexity of the waste materials and the great variability of sample matrices represented special difficulties during both sample preparation and the analytical step. Since most of the methods used in the Laboratory Branch are designed for the analysis of air, water, fish, sewage, vegetation, soil and sediment materials, application of these methodologies to the analysis of industrial waste samples could only be

feasible if some compromise be made on the accuracy of analytical data. This compromise should not, however, cast significant doubt on the value and validity of results especially if characterization and classification of the waste is the target.

Further work should follow with the main objective to establish accurate and more reliable methods for the analysis of such unusual environmental samples. Because of the unusual nature of the samples, LSB Sections were requested to provide their analytical data accompanied with "qualifying statements" of their analyses which include as many of the following as reasonably possible.

1. Method(s) of analysis and sample preparation;
2. Instrumentation used and its parameters if different from routine methods;
3. Qualifying statements of the data including:
   (a) level of confidence
   (b) accuracy of results where applicable
   (c) detection limit(s)
   (d) quality control where applicable
4. Reference to samples which showed special difficulties, interference and/or contradicting results;
5. Comments on handling of such wastes in the future and recommendations.

8. ANALYTICAL PROCEDURES USED

The following briefly describes the analytical methods used by LSB Sections for the characterization of various chemical agents in these wastes.

A. ANALYTICAL PROCEDURES AND QUALITY CONTROL DATA

WATER QUALITY SECTION

The following tests were performed:

pH, acidity or alkalinity, and a scan for common inorganic anions utilizing the Dionex ion chromatographic system

Apparatus

Dionex Ion Chromatograph

Radiometer portable pH meter

Radiometer combination calomel glass electrode #GK 2401C

Graduated disposable pipettes of 1.0, 5.0 and 10.0 ml capacity

Beaker for waste liquid

450 ml sample bottles

2 wash bottles

2 x 50.0 ml burettes with filling tubes

Burette clamp

Retort stand

1000 ml plastic sample bottle

1000 ml glass reagent bottle

3 aspirators

12 cm. diameter magnetic stirrer

100 ml volumetric pipette

2 dropper bottles

2 x 50 ml dilution tubes

Disposable 10 ml syringes

15 cm x 25 cm plastic bags with twist ties

6 x 200 ml berzelius beakers

Safety Equipment

Glove box

Box of disposable gloves

Back opening laboratory coat

Safety glasses

Nalgene acid carrier

2 - 50 cm x 100 cm trays for possible spills

5 x 5 gal. (US) collapsible bags for liquid waste

plastic garbage bags for solid waste

Reagents

pH: buffers pH 7.0, pH 4.0 and pH 9.0

Acidity: .02N NaOH titrant

.02 N H_2SO_4 calibration standard

0.5% phenolphthalein

Alkalinity: .02 N H_2SO_4 titrant

0.01% methyl orange solution

Anion Scan: The standards were prepared by diluting a combined standard stock solution. The stock solution contained:

0.888 g/l^{-1} NaF

2.4728 g/l^{-1} NaCl

11.249 g/l^{-1} K_2HPO_4

14.436 g/l^{-1} KNO_3

14.786 g/l^{-1} Na_2SO_4

This solution was diluted 100 times to form what was called the "100% standard" with anion concentrations of: 4.00 mgl^{-1} F, 15.0 mgl^{-1} Cl, 20.0 mgl^{-1} PO_4 as P, 20 mgl^{-1} NO_3 as N, and 100 mgl^{-1} SO_4. Similarly, other dilutions were prepared to produce 10%, 20%, 40%, 60%, and 80% full scale standards.

PROCEDURE

Sample Handling and Waste Disposal

CHLIW samples were stored in one fume hood; in groups of five to six, the samples were transferred to the glove box. The glove box already contained all the equipment and supplies required for pH measurement and sample dilution including labelled plastic containers filled with 450 ml deionized distilled water. The glove box also contained a plastic bag for solid wastes and a 5 gallon (U.S.) plastic container for liquid wastes. All operations involving liquids were conducted within the glove box on a large tray with 2" sides.

The glove box was then sealed. A dilution of each sample was prepared, pH was determined and after about 15 minutes had elapsed since the samples were exposed to the air, the glove box was opened, and the diluted samples were taken to the fume hood in the precipitation lab., and the original samples were returned to Dr. Moselhy's fume hood. Solid and liquid waste containers were sealed and taken to the storage area in shipping and receiving specially designated for CHLIW waste.

pH

Before being placed in the glove box, the pH system was calibrated using 1 pH 7 buffer; the calibration was checked by analyzing buffers with pH values of 4.00 and 9.05 units. All readings were based on quiescent conditions similar to those described in the report: "pH measurements on Precipitation Samples by J. Crowther and O. Lindow (JC 7905)". The pH of actual samples was measured in the glove box by inserting the combined glass-calomel electrode directly in the sample, i.e. no stirring. Between measurements, the electrode was rinsed with deionized distilled water, and the washings transferred to a 5 gallon (U.S.) waste container.

Alkalinity

An appropriate aliquot (1.00-100 ml) of the diluted samples (1.0% v/v) was titrated with 0.02 N sulphuric acid to the methyl-orange end point. As the colour of sample T41-19 obscured the colour change at the endpoint this sample was titrated to pH 4.5 using the Radiometer pH meter and combined electrode. All titrations were conducted in a fume hood. This manual procedure is similar to that described in Standard Methods for the Examination of Water and Wastewater, 14th Ed. P. 278.

Acidity

The normality of a 0.02N Sodium hydroxide solution was determined daily by titrating with 0.02 N sulphuric acid to the phenolphthalein endpoint. Appropriate aliquots (1.0 -100 ml) of the diluted test samples (1.0% v/v) were

titrated with this sodium hydroxide solution to the phenolphathalein endpoing. All titrations were conducted in a fume hood. This procedure is similar to that described in Standard Methods for the Examination of Water and Wastewater, 14th Ed., p.273.

Anion Chromatographic Scans

The Dionex Model 16 Ion Chromatographic system was operated under the conditions described below. Background information on this procedure is available in the report: "Analysis of Precipitation Samples by Ion Chromatography Part 1 - Determination of Anions" by Joan Crowther and Jenifer McBride (JC 7801) dated June 30th, 1978.

Operating Conditions for Ion Chromatographic System

Time Cycles:	Analytical Mode: 2 - 3 hr. Regeneration Mode: .5 hr.
Eluent:	Composition: 0.003 N $NaHCO_3$/0.0012 N Na_2CO_3 Flow Rate: pump at 35% flow.
Sample:	Volume: 0.10 ml.
Precolumn:	Size 3 mm I.D. x 125 mm. Purpose: to trap foreign matter.
Separator:	Size: 3 mm I.D. x 500 mm.
Suppressor:	Size: 3 mm I.D. x 250 mm. Interchangeable matched suppressors were used. Regenerator: 1 N H_2SO_4 Regeneration cycle: Acid flow at 280 ml hr^{-1} for 2 min. Water flow at 280 ml hr^{-1} for 15 min.
Detector:	Conductivity meter: 30 μscm^{-1} full scale
Chart Recorder:	Pen 1: high analytical range - full scale equivalent to 30 μscm^{-1} Pen 2: low analytical range - full scale equivalent to 15 μscm^{-1}
Calibration:	6 mixed standards. Calibration curves based on peak height.

B. PROCEDURE FOR MICROBIOLOGICAL ANALYSIS OF CHLIW LIQUID INDUSTRIAL WASTE SAMPLES BY MICROBIOLOGY SECTION:

Objective

Microbiological analysis of hauled liquid waste (CHLIW) samples were conducted: (a) to determine levels of water quality indicator bacteria in these wastes, and (b) to determine if such waste samples contained pathogenic bacteria.

Methods

(a) Sample Selection:

Waste samples, which were suspected of containing nutrients supportive of bacterial growth and which were assumed relatively free of toxic materials, were selected for analysis. Samples originating from food processing wastes were considered ideal for such analysis. Additional samples originating from a cosmetics industry and a petroleum industry were also analysed. These wastes were included in the study to determine if their bacterial types differed from those in food processing wastes.

(b) Microbiological Analysis:

(i) Sampling and Storage of Samples:

Samples for microbiological analysis were collected in pre-sterilized glass bacteriological sample bottles, supplemented with sodium thiosulphate. These samples were delivered directly to the laboratory or transported to the laboratory in insulated containers with ice. In the laboratory, all samples were stored at $4^{o}C$ and analysed generally within 24 hours, but not later than 48 hours from the time of collection. Waste samples were taken specifically for microbiological analysis in order to assure these sample storage and transportation criteria were met.

(ii) Microbiological Analyses:

Numbers of specific bacterial types were generally enumerated using the membrane filtration technique. In those cases where (a) the sample consistency was not conducive to filtration, or where (b) an analytical method incorporating membrane filtration was not available, bacterial levels were calculated utilizing the most probable number (MPN) technique. In the analysis for Salmonella sp., the bacteria in the samples were concentrated on one or more membrane filters which were then transferred to an enrichment media. After an appropriate incubation time, the enriched bacterial population was tested for the presence of Salmonella sp. using selective agar media.

Samples were diluted to obtain bacterial numbers within the desired counting range using a one in ten serial dilution technique in sterile buffered water (1).

Samples were analysed for numbers of the following water quality bacteria: Total coliforms, Fecal coliforms, and Fecal streptococci. The following pathogenic or opportunistic pathogenic organisms were enumerated: Escherichia coli, Staphylococcus aureus, Pseudomonas aeruginosa, Aeromonas hydrophila, and Klebsiella pneumoniae. A technique for the detection of Salmonella sp. was also employed. The petroleum industry inert sludge waste was also analyzed utilizing the MPN technique for sulphate reducing and denitrifying bacteria, as well as for Nitrosomonas sp. and Nitrobacter sp.

C. DETERMINATION OF POLYCHLORINATED BIPHENYLS IN CHLIW SAMPLES

Polychlorinated biphenyls (PCB's) have been used for many applications such as: a filling agent or impregnator in transformers and power capacitors, as a hydraulic fluid, in diffusion pump oil, in heat transfer applications, plasticizers, and in some air conditioner and refrigerator electrical circuits. Such products may contain PCB's in concentrations up to 100%.

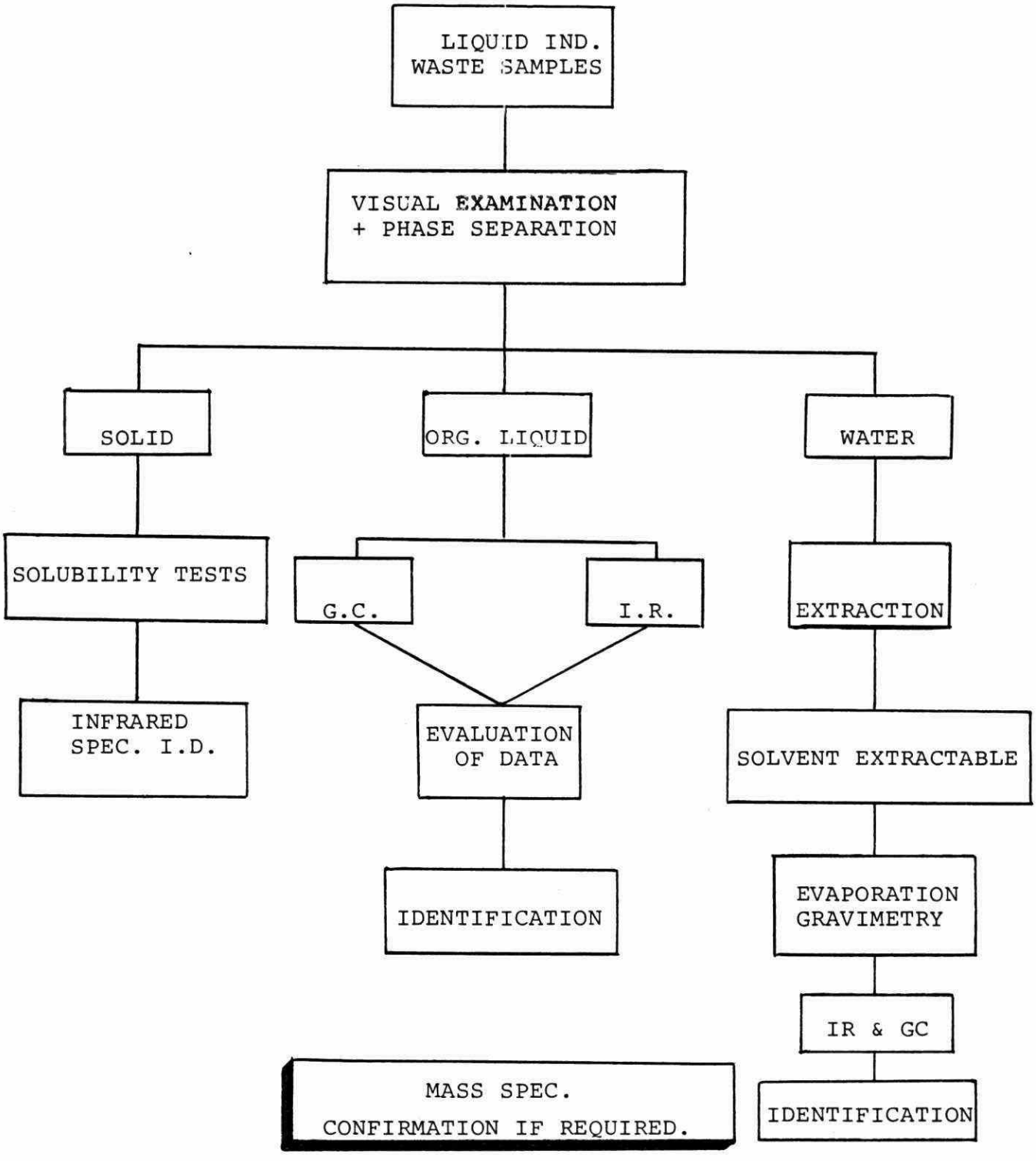
Method of Analysis

PCB's are extracted from oil waste samples using methylene chloride as extractant. The resulting extract is then diluted to a suitable volume prior to cleaning and analysis.

An aliquot of the extract is taken for Florisil column chromatographic cleaning using selected solvents to separate PCB's from interferring compounds. The eluate is then evaporated to a pre-determined volume, and analyzed by electron capture Gas Chromatography. The resulting chromatogram is compared to that of known PCB standards for identification and quantitation.

In this work, a detection limit of 25 ppm was established for PCB's in CHLIW waste oils.

D. SCHEMATIC REPRESENTATION OF THE GENERAL CHARACTERIZATION OF ORGANIC INDUSTRIAL WASTES



E. DETERMINATION OF HEAVY METALS IN CHLIW INDUSTRIAL WASTE SAMPLES; INORGANIC TRACE CONTAMINANTS SECTION

Because of the highly variable nature of the sample type, several sample preparation procedures were required.

1. Liquids amenable to acid digestion:

   5g of sample slowly and carefully digested with HCl: HNO_3 (conc. 15:5ml). Any residue was filtered, ignited, and analyzed by powder plate DC arc emission spectroscopy. The digestate was analyzed by inductively coupled plasma plate emission spectroscopy.

2. Solids:

   0.5 - 2g sample digested in a Parr bomb with HNO_3, then treated as in (1).

3. Organic Samples:

   1 - 5g os sample was very slowly ashed in a porcelain crucible by raising the temperature in small increments to 500°C. The residue was analyzed by DC arc emission spectroscopy.

4. Multiphase Samples:

   Where distinct phases were observable (e.g. oil and water) the phases were analyzed separately by employing the above procedures.

D.C. Arc Emission Spectrometric Analysis:

An aliquot of ignited solid sample is mixed with graphite and lithium carbonate. A portion of the mixture is placed in a graphite electrode which is used as one pole of a DC arc. The arc volatilizes, atomizes and excites the sample. The emission spectrum is recorded on a photographic plate which is interpreted by microphotometer comparison to similarly treated standards.

ICAP-ES

Acid digests were aspirated into an inductively coupled plasma source and the emission spectra recorded and interpreted as above.

F. GAMMA SCAN OF ELDORADO WASTES, RADIATION PROTECTION LABORATORY, (RAFFINATE) MINISTRY OF LABOUR

Two samples of Eldorado waste (T43-42, Sept. 15, 1980, sediment and liquid) were received on October 22, 1980. One was in a wide-mouthed 2-L plastic container and the second in a small-mouthed 1-L glass bottle.

Because of expected problems in transferring the samples and in getting homogeneous aliquots, gamma scanning was made on the samples in their original containers.

Geometry was simulated by taking similarly-sized containers and filling to the same volume as the sample with water spiked with mixed gamma standard. An efficiency calibration curve for each geometry was then obtained.

The sample in the plstic container (80-686-1) had a volume of $\sim$ 1.75 L and the sample in the glass bottle was approximately 1L. The assumption made in the analysis is that the radioactive components are homogeneously distributed in the sediment and liquid.

The samples were allowed to stand for several weeks to allow equilibrium between radium-226 and its daughters and thorium-228 and its daughters. They were then counted for 2000 s each.

Activity of Th-234 (U-238 daughter) was obtained from the 63.3-keV peak. It is not known whether Th-234 ($T_{\frac{1}{2}}$ = 24d) is in equilibrium with U-238.

Activity of Ra-226 was obtained from the peaks of its daughters, Pb-214 (295.2 keV) and Bi-214 (609.4 keV and 1764.7 keV), with which it is believed in equilibrium.

Activity of U-235 was obtained from the 143.8-, 163.4- and 205.3-keV peaks.

Activity of Ra-228 was obtained from the peaks of Ac-228 (338.5, 911.1 and 968.9 keV). Whereas Ac-228 ($T_{\frac{1}{2}}$ = 6.13 h) is surely in equilibrium with Ra-228 ($T_{\frac{1}{2}}$ = 5.7 y), it is not known whether the latter is in equilibrium with its parent, Th-232.

Activity of Ra-224 ($T_{\frac{1}{2}}$ = 3.64 d) and, therefore, of Th-228 was obtained from the Tl-208 peaks (510.7 keV and 583.1 keV).

The results are as follows:

	T43-42	
Activity in sample	1	2
Th-234, mCi	0.51	0.36
Ra-226, µCi	0.15	0.25
U-235, µCi	0.27	0.12
Ra-228, µCi	0.05	0.24
Th-228, µCi	0.42	0.34

9. CHARACTERIZATION OF WASTES RELATIVE TO THEIR CLASSIFICATION

Sampling of environmental materials remains an integral part of the analytical processes. The evaluation of sampling procedures is beyond the scope and objectives of this report, and accordingly no review of them was attempted here. However, if similar programs are to be continued a thorough review and documentation of sampling procedures of various types of liquid waste would be recommended.

Within the context of this set of samples, the LSB had to specifiy the required quantity of samples and submission times as in the case of samples which were assigned to microbiological testing. Regional staff were advised to take all possible precautionary measures to ensure the safe handling and transportation of hazardous samples. The MOE Central Laboratory supplied regional staff with twin styrofoam packing boxes containing a pair of one litre glass bottles. One of the bottles had an aluminum foil screw cap lining and was assigned to organic analysis. The second bottle was for inorganic samples and had a plastic lined screw cap. Samplers were also requested to provide all the available information on those samples which could present any hazard to the analysts. Preservation of metals was not attempted due to the high organic content, the possibility of chemical reaction in the wastes, and the need to estimate certain parameters such as pH, acidity and alkalinity.

In order to further ensure both the safety of LSB staff who handled the samples at various stages of the analytical train and a smooth flow of work to various laboratory units, the duplicate samples were colour coded for each section's attention. Listing of the samples which required the attention of each section accompanied copies of the sample submission forms together with any available information on the possible sample composition.

Furthermore, the samples were stored in two well-vented fumehoods to reduce personal exposure. Also, a separate, properly vented and controlled space in the storage area was assigned to the storage of wastes left from analyses as well as the completed samples in preparation for their disposal. Samples which were suspected of containing hazardous compounds, for example PCB, were first analyzed for these parameters prior to their analyses in other sections. During the course of sample preparation and analyses it was necessary to build a temporary well-vented glove box, which was used for the preparation and sample analyses for anions. The Pesticides, ITC, and OTC sections handled their samples using regular fumehoods and safety precautions.

Organization and Distribution of Responsibilities

Several meetings were held to plan the smooth analysis of these samples. Detailed minutes for these meetings are available upon request. Generally, each LSB section agreed to perform agreed upon parameters, give CHLIW samples a high priority, and attempt to use a "One Window" approach via Dr. Moselhy. Various memoranda were prepared and in-house meetings minutes; these are available upon demand.

Results

Although the ultimate goal of the study is binding to both the Waste Management and Laboratory Services Branches, the objectives of each might be different. As an example, the LSB role can be mainly defined in providing the required analytical support. Any conclusions and recommendations would be based on the analytical findings. The WMB objective might best be related to the evaluation of the Waybill operation based on the Waste Classification Guideline. Interbranch co-operation would then streamline the recommendations drawn from the two objectives toward the common goal.

Part A presents the analytical information obtained by the Organic Section in the form of separate reports. Part B presents the Water Quality data, Part C shows the Microbiology results and Part D summarizes the findings of the Pesticides Section. Due to the large number of heavy metal parameters, the results were presented in the collective tables (Part E). This arrangement of the data provides a correlative view of the organic and inorganic findings. Extracts of the most significant analytical findings were also tabulated separately in table F together with the corresponding expected and proposed waste classification type. The latter was determined on the basis of chemical composition of the material and the reasons for the change was briefly described where possible. In some case, samples could not be related to waste classification types either due to the absence of a classification for waste water or to the incompatibility of the waste to common industrial wastes.

On the other hand, some of the analyzed wastes were classified as organic solvents which would ordinarily indicate monitoring for organic compounds only. However, a number of these wastes showed the presence of relatively high concentrations of toxic or possibly toxic metals. In this regard, the absence of a separate classification type such as "metal contaminated organic liquid waste" might fail to attract the analyst's attention to measure both inorganic and organic components of these samples. In a similar example, a sample from Ford Motor Co. in Windsor contained 25 ppm PCB, yet no analyst would have expected the presence of PCB's from the classification provided. Such a problem could be anticipated in samples from other companies which either use, refine or incinerate recycled combustible liquids or waste oil. In fact, this particular sample, according to the request for analysis, did not originally require the attention of the Pesticides Section and only an educated guess led to the identification of PCB.

One might argue that the measured level of PCB is relatively low, or that it approaches the acceptable level for road oiling purposes. However, the more important matter is: how do we know whether the next batch of waste contains high levels of PCB, or some other toxic contaminant in the first place? The MOE policy in such cases has always been and still is in the direction of imposing protective measures on any hazardous or potentially hazardous chemical agent.

LSB NUMBER	SUBMITTED CLASS	PROPOSED CLASS	REASON	SAMPLE DESCRIPTION	PERTINENT ANALYSIS	SIGNIFICANT ANALYTICAL PARAMETERS
T41-18	101	402	solid sludge	heavy non-pourable black sludge	metals	high iron
T44-19	101	102	alkaline	dark red liquid with bluish solids	metals anions	low metals PH 8.3 alkalinity 25,000.
T42-13	102	no change	no change	orange colour gel	organics	organics: No data.
T43-6	102	103 301	paint	pink paint-like liquid	metals	high: Al, Fe, Ti, AS and Zn.
T43-14	102	102 201	alkaline oily water	light brown liquid with oil layer	metals anions PCB	high: Al, average Fe, Mn, Cr and Cd. PH 12.3, alkalinity 83,000. No PCB.
T43-15	102	no change	no change	green liquid with green residue	metals anions	high: Al, Fe, Mn, B, Pb, Sn, V, Cu, Ni, Zr, Cr. PH 12, alkalinity 49,000, Fl^- 1700, $So_4^=$ 15,000; No PCB.
T43-16	102	102 103	alkaline metal finish-ing waste	dark brown liquid with residue	metals anions PCB	high: Al, Fe, Ca, Ti, Ba, Pb, Sn, Cr, Zn, Co. PH 12, alkalinity 15,000, Fl^- 30,000, Cl^- 2,300. No PCB
T43-17	102	no change	no change	light brown clear liquid with brown residue	metals anions PCB	high: Al, Fe, Ti, possible interf. on Hg. PH 11.5, alkalinity 620,000, Fl^- 400. No PCB
T43-18	102	102 103	alkaline metal finish-ing waste	medium brown viscous liquid, some oil	metals anions PCB	high: Al, Fe, Mn, B, Pb, Ni, Cr, Cd, Co. Interf. Hg; PH 12, alkalinity 27,000, Fl^- 660 , $So_4^=$ 34,000. No PCB.

LSB NUMBER	SUBMITTED CLASS	PROPOSED CLASS	REASON	SAMPLE DESCRIPTION	PERTINENT ANALYSIS	SIGNIFICANT ANALYTICAL PARAMETERS
T43-19	102	no change	no change	brown liquid with black residue	PCB anions metals	No PCB (<1ppm), PH 12 High: Al, Fe, average Cu, Pb, Zn, Ni, Cr and Mn, low Cd.
T43-20	102	no change	no change	brown liquid with grey residue	PCB anions metals	No PCB (<1ppm), PH 1 high: Fe, average Cu, Pb, Al, low Cd, Zn,Cr and Mn.
T43-21	102	102 + 103	alkaline metal finish-ing waste	brown liquid with grey residue	PCB anions metals	No PCB (<1ppm), PH 11 high: Cu, Zn, Pb, Al, Fe, Cr; average: Ni, Mn; low Cd.
T43-34	102	103 or a new Class as waste water	PH 7.8 some metals are high	colourless liquid plus 5% particles	metals anions	high: Fe, Ca, Mg, Mn, average: Pb, Co; Zn unknown PH 7.8, low anions
T44-11	102	no change	no change	very dark clear red-brown liquid plus black solid on surface	metals anions PCB	high: Al, Fe, Ca, Mg, Pb; PH 12.5, alkalinity 49,000.
T44-18	102	no change	no change	clear off white liquid plus brown suspended solid	metals anions	high: Al, Mg, Sn, average Ca,Mn, Cr, unknown Zn, PH 10.9, alkalinity 72,000.
T41-6	103	no change	no change	metal finishing liquid	metals	high: Fe, Ca, Mg, B, Ni, Co, Cr, average Al, Ba, Sn, Cr, Sr, unknown Zn.
T41-16	103	no change	no change	nickel plating waste: Duplicate is different	metals	high: Ni, B, Co and Cd
T43-33	103	101 + 103	PH 0.6 certain metals are high	dark brown liquid with 2% solids and oil	metals anions	high: Ca, Mg, B, Cu, Zr, Cr(major), Interf. Fe, Co, PH 0.6, acidity 61,000, Fl^- 1,800, SO_4^- 4,800.

LSB NUMBER	SUBMITTED CLASS	PROPOSED CLASS	REASON	SAMPLE DESCRIPTION	PERTINENT ANALYSIS	SIGNIFICANT ANALYTICAL PARAMETERS
T46-15	103	no change	no change	yellow-black viscous liquid	metals anions	high: Al, Ca, Mg, Cr, Co, unknown Hg (<80). PH 6.5, acidity 16,200.
T46-16	103	no change	no change	yellow-black liquid	metals	high: Al, Cr, Co, Zn, low Pb, Sb, Mn.
T37-14	190	102	PH > 11	clear, off-white liquid with suspended particles	metals anions	V > 4ppm. unknown Zn, PH > 11.
T41-4	190	101 + 103	PH 0.0	yellow liquid + 5% solids	metals anions	high: Al, Fe, Mn, B, Pb, V, Mo, Cu, Ni, Zr, Cr, Cd. PH 0.0, acidity 430,000, Fl^- 160, Cl^- 318,000, $So_4^=$ 31,000.
T41-9	190	New class (waste water)	No significant contaminants	black liquid with oil slick + 5% black particles	metals anions	no significant contaminants.
T41-19	190	102	alkaline	dark red liquid with bluish residue	metals anions	no significant metals. PH 8.3, alkalinity 25,000.
T42-5	190	102	alkaline	66% white solid in 33% liquid	metals anions	high: Al, Fe, Ca, Mg, low Cu, Cr, unknown Zn and Hg, PH12.7, alkalinity 2,000.
T43-31	190	no change	no change	colourless liquid with oil slick and 1% suspended matter	metals anions	none
T43-42	190	new class for radio-active waste	Radio-active	colourless liquid above solid wax-like material	radiation level γ-ray spect.	see attached MOL report.

LSB NUMBER	SUBMITTED CLASS	PROPOSED CLASS	REASON	SAMPLE DESCRIPTION	PERTINENT ANALYSIS	SIGNIFICANT ANALYTICAL PARAMETERS
T41-1	190	290 or 401	animal fat	semiclear greyish liquid + particles.	metals organics anions	none.
T42-10	201	new class for waste water	no oil in sample	25% solids 25% susp. solids, orange liquid	metals anions	high: Al, Fe; average Mn, low Pb; AS ≈ 10ppm Cd 2-10ppm, unknown Zn.
T42-37	201	102 + 201	alkaline waste	yellowish-brown liquid + heavy fine particles	metals anions	high: Fe, Ca, average B, Cr, low Cu, Ag, unknown Zn; PH 7.7, $So_4^{=}$ 4,600.
T43-24	201	202 + 203	oil and solvent mixture	amber colour mobile oil with hydro-carbon ordour	metals organics	average Zn, low Pb, Ti, Cd, Ba, Fe. Naphthanic base compounds.
T43-30	201	no change	no change	waste water	metals	none.
T44-10	201	202	no change	heavy viscous metallic grey suspension	metals PCB organics	high: Al, Fe, Ti, Pb, Cr; low V, Mo; unknown Co, Zn. Medium petroleum derived oil--base lubricant.
T44-12	201	201 + 203	oily water with solvent	two layer oil and water	metals organics PCB	low Pb, Cu, Ni, ≈ 5% trichloroethane oil layer is petroleum derived aromatic solvent and process oil
T44-14	201	no change	no change	oily waste water	metals PCB organics	High: Ca, Cu, average Sn, Fe, Mg; unknown Zn, No PCB, organics: No data.
T44-15	201	no change	no change	Spin finishing sludge	metals organics	high: Sn; Average Ca, low Fe, B, Cu, unknown Zn. Organics: No data.

LSB NUMBER	SUBMITTED CLASS	PROPOSED CLASS	REASON	SAMPLE DESCRIPTION	PERTINENT ANALYSIS	SIGNIFICANT ANALYTICAL PARAMETERS
T44-45	201	no change	no change	-	metals organics	high: Al, Fe, Ca, Mg, B, low Cu, Cr, Mn, Ti. organics: No data.
T43-1	202	202 + 209	PCB contaminated oil	dark brown mobile quenching oil	PCB organics	PCB content: 25ppm high aromatic hydrocarbons.
T43-22	202	201	5% oil on water	medium viscosity oil on water	metals organics	high: Al, Fe, Ca, Mg, Ti, Ba, Pb, Ni and Zn. Paraffinic and naphthanic petrol.
T43-23	202	no change	no change	dark mobile oil or mixed waste	metals organics	high: Al, Fe, Ca, Mg, Ti, Mn, Ba, Pb, Cu, Cr, Zn, Average Ni, Bi, Sn, B. C-15 to C-25 hydrocarbons.
T43-32	202	202 + 402	oil and sludge	dark oil with sludge residue	organics PCB	see analysis
T43-39	202	no change	no change	-	PCB organics	no PCB. Organics: No data.
T41-10	203	201	oily water organic solvent styrene	two clear colourless layers	organics	organic layer is pure styrene; water layer is styrene saturated, PH 7.3.
T41-15	203	203	mixture of solvents and resin (paint sludge)	2/3 paint sludge + 1/3 organic solvents	organics	presence of aromatic hydrocarbons, ketones, alcohols and varnish naphtha.
T42-25	203	203 + 301	mixture of solvents and paint	dark colour with strong odour.	organics	75% substituted aromatic solvents, long alkyl alcohol and esters. 25% alkyl resin.

LSB NUMBER	SUBMITTED CLASS	PROPOSED CLASS	REASON	SAMPLE DESCRIPTION	PERTINENT ANALYSIS	SIGNIFICANT ANALYTICAL PARAMETERS
T42-18	203	203 + 301	solvent-paint mixture	bad paint waste with typical aromatic odour	metals organics	high: Fe, Ca, Ti, Mn, Pb, Zr, Co, Zn; Average Cd, B, Ni; and suspected Hg. Toluene, xylene and resin mixture.
T42-39	203	no change	no change	dark mobile liquid with aliphatic odour	metals organics PCB	high: Al, Fe, Ca, Cu; odour of aliphatic ketones; aromatic hydrocarbons and 10% carbonyl compounds (ketones).
T43-7	203	102 + 201	alkaline waste	wine-red liquid with oil slick and 5% residue	metals anions organics	high: Ca; average, Mg, Al, Fe, Ti low B, Cu, Zn. PH 12.6, alkalinity 45,000. organics: No data.
T43-11	203	no change	no change	brown mobile organic liquid	organics	ketones, alcohol and some aromatics. 5% polyester resin.
T43-12	203	no change	no change	yellowish mobile organic liquid	organics	petroleum derived solvents.
T43-25	203	203 + 103	metal-organic solvent mixture	dark red-amber colour mobile liquid + suspended matter	metals organics PCB	high: Al, Fe, Ca, Mg, average Ti, Ba, Pb, Cr, Zn. No PCB. Xylene and ethoxylated alkyl non-ionic surface activ agent.
T43-26	203	no change	no change	amber colour mobile liquid	metals organics PCB	low metals No PCB. xylene and non-ionic surface active agent.
T43-36	203	no change	no change		organics	No data.
T41-8	204	no change	no change		metals organics	low metals. no organics data

LSB NUMBER	SUBMITTED CLASS	PROPOSED CLASS	REASON	SAMPLE DESCRIPTION	PERTINENT ANALYSIS	SIGNIFICANT ANALYTICAL PARAMETERS
T43-28	204	no change	no change	two layer liquid yellow and dark layers	organics	tetrachloroethylene, and a mixture of petroleum distillate.
T43-40	204	201 + 203 + 204	oily water with solvents	two layer liquid	organics	some chlorinated solvents, non-ionic surfactants, toluene and aliphatic ketones.
T41-11	205	no change	no change	milky white emulsion- 3 - 4% solids	organics	PH 5 -6. Uncharachteristic latex, uncommon to commercial polymers.
T42-29	205	203 + 205	presence of chlorinated solvents and resins	aromatic odour liquid with 66% non-volatile solids	metals organics	high: Ca, Mg; low others dipropylene glycol, alkyd resin, aromatic hydrocarbons and chloroform.
T43-3	205	301 + 205	paint resin	paint waste (Plastisol)	metals	high: Al, Fe, Ca, Mg, Ba, Pb, Sr; average Ti, Mn, Cu. suspected Hg.
T43-5	205	no change	no change	no change	metals organics	low metals. organics: No data.
T44-17	205	no change	no change	no change	organics	no data.
T41-21	206	no change	no change	no change	metals organics	high: Al, Fe, Ca, Mn, Cr, average Ni, Co, Zn. organics: no data.
T41-12	207	no change	no change	mixture of colourless syrupy liquid and solids	organics	oligomers and polymers of propylene glycol.

LSB NUMBER	SUBMITTED CLASS	PROPOSED CLASS	REASON	SAMPLE DESCRIPTION	PERTINENT ANALYSIS	SIGNIFICANT ANALYTICAL PARAMETERS
T41-14	207	no change	no change	no change	organics	no data.
T43-10	207	101 or 290	5% maleic acid solution low PH	clear straw colour with acetaldlyde odour	organics	low PH. high concentration of maleic acid. Metal analysis is recommended.
T41-20	208	no change	no change	no change	metals organics	low metals. organics: No data.
T12-4	208	no change	no change	no change	organics	no data.
T44-20	208	no change	no change	no change	PCP	no chlorophenols. (D.L. 1ppm).
T44-21	208	no change	no change	no change	PCP	No chlorophenols (D.L. 1 ppm).
T41-7	290	190 + 290	high metals	no change	metals organics	high: Al, Fe, Ti, B, AS, Zn. unknown Hg. organics: no data.
T41-22	290	no change	no change	no change	metals organics	high: Al, Ca; average Fe, Mg; low Pb, Ti, Cu. organics: no data.
T41-23	290	no change	no change	no change	organics	no data.

LSB NUMBER	SUBMITTED CLASS	PROPOSED CLASS	REASON	SAMPLE DESCRIPTION	PERTINENT ANALYSIS	SIGNIFICANT ANALYTICAL PARAMETERS
T43-9	290	205 or 203	organic solvents	viscous oily light colour	organics	presence of octanol, ethyl hexanol, and lon chain mono or dicar-boxylic acids.
T43-13	290	290 + 101	acidic	no change	metals anions organics	high: Pb; average Fe, Ca, Mg, Sn, Sr. PH 4.5 organics: no data
T42-8	301	no change	no change	grey emulsion paint waste	metals organics PCB	high: Sn, Cr, Cd, No PCB. Substituted aromatics and styrene monomer.
T42-30	301	no change	no change	pale green aquous solution	metals organics	high: Al, Fe, Ca, Mg, Ti, Zn, average Mn, Ba, V, Cu. Polyvinyl acetate.
T43-2	301	no change	no change	paint waste (sludge)	metals	high: Al, Fe, Ca, Mg, Ti, Ba, Pb, Zr, Cr, AS, Zn; average Mn, B, Sn, Cu, Ni.
T43-27	301	no change	no change	thick coloured paste	metals PCB organics	high: Al, Fe, Ca, Mg, Ti, Ba, Pb, Cr, Zn; average Cu, Sn, no PCB. Silicate base.
T43-35	301	no change	no change	no change	organics PCB	organics: no data no PCB.
T44-8	301	no change	no change	no change	organics PCB	organics: no data. no PCB.
T44-9	301	no change	no change	no change	organics PCB	organics: no data no PCB.

LSB NUMBER	SUBMITTED CLASS	PROPOSED CLASS	REASON	SAMPLE DESCRIPTION	PERTINENT ANALYSIS	SIGNIFICANT ANALYTICAL PARAMETERS
T44-16	301	no change	no change	no change	organics	no data.
T42-6	302	no change	no change	pesticide waste	Pesticides	presence of Triazene, other similar chlorinated compounds and heterocyclic compounds, Atrazine & 2.4 D see detailed results.
T42-27	302	no change	no change	Pesticide waste	pesticides	presence of naphthalene methyl naphthalene, Dimethyl naphthalene, Triazole type compounds and glycols. see detailed results.
T42-36	303	102 + 303	alkaline waste	no change	anions organics	PH 12.6, alkalinity 117,000 Flourinde 1200, chloride 2200 sulphate 1300.
T43-37	303	401 or 303	saponified fatty acid	dark grey solid grease-like material	organics	57% fatty acids.
T43-41	303	401 or 303	saponified fatty acid	dark yellow solid (grease)	organics	55% long chain fatty acids.
T48-20	303	no change	no change	no change	organics	no data.
T41-17 (duplicate)	203	sample A 204 + 304 sample B) 101	two different samples	A) yellow liquid B) mobile reddish-brown liquid	organics	A) 60% chloroform, 40% ethanol B) Acetic acid with 10% solid content.
T42-26	401	no change	no change	food waste	micro-biology	see results.

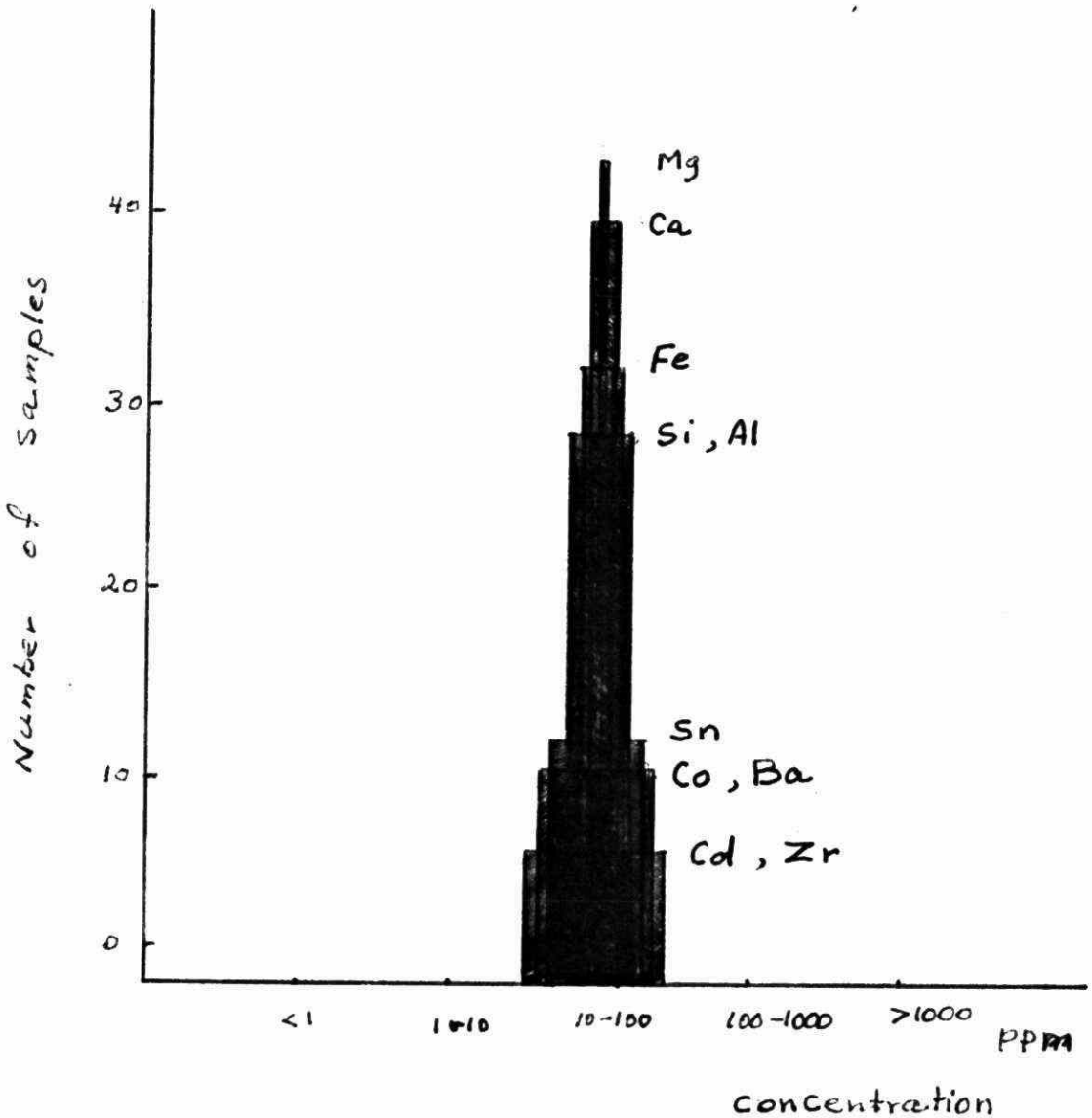
LSB NUMBER	SUBMITTED CLASS	PROPOSED CLASS	REASON	SAMPLE DESCRIPTION	PERTINENT ANALYSIS	SIGNIFICANT ANALYTICAL PARAMETERS
T43-38	401	no change	no change	no change	organics microbiology	organics: no data. microbiology: see detailed analysis.
T44-7	401	no change	no change	no change	organics PCB	organics: no data. No PCB.
T45-46	401	no change	no change	turbid water with oil slick	metals organics	low metals. oil layer is a paraffinic base oil with some solvents, starch and fibers.
T46-1	401	no change	no change	Rye mash syrup	metals	high: Al, Fe, Ca, Mg, low Cu, Mn, B, Pb and Zn. Interference on Hg.
T41-5	402	no change	no change	inert sludge	metals microbiology	high: Al, Fe, Cu, Ca, Mg; low Ti, Mn, B, V. microbiology: see details.
T42-7	402	no change	no change	1/3 yellow-white liquid 2/3 grey solid	metals organics anions	high: Al, Fe, Ca, Mg, Ba, Bi, Cu, Cr, Cd, Sr; low Ti, B, Pb, Co. PH 8.4, Sulphate 24000, Cyanide 16. no organics.
T42-9	402	no change	no change	no change	metals organics	high: Al, Fe, Ca, Mg, Ti, Mn, average Ba, Pb, Mo, Cu, Cr, Co, Sr. No organic data.
T43-4	402	no change	no change	no change	metals anions	high: Ca, Mg, Sn, Ni, Zr, average Al, Fe, Mn, V, Ag, Cr; PH 8, chloride 1250, nitrate 19000, sulphate 5600.
T43-8	402	no change	no change	no change	metals organics	high: Al, Fe, Ca, Mg, Ti, low Mn, B, AS. PH 8.1 chloride 1250, nitrate 19000 sulphate 5600.

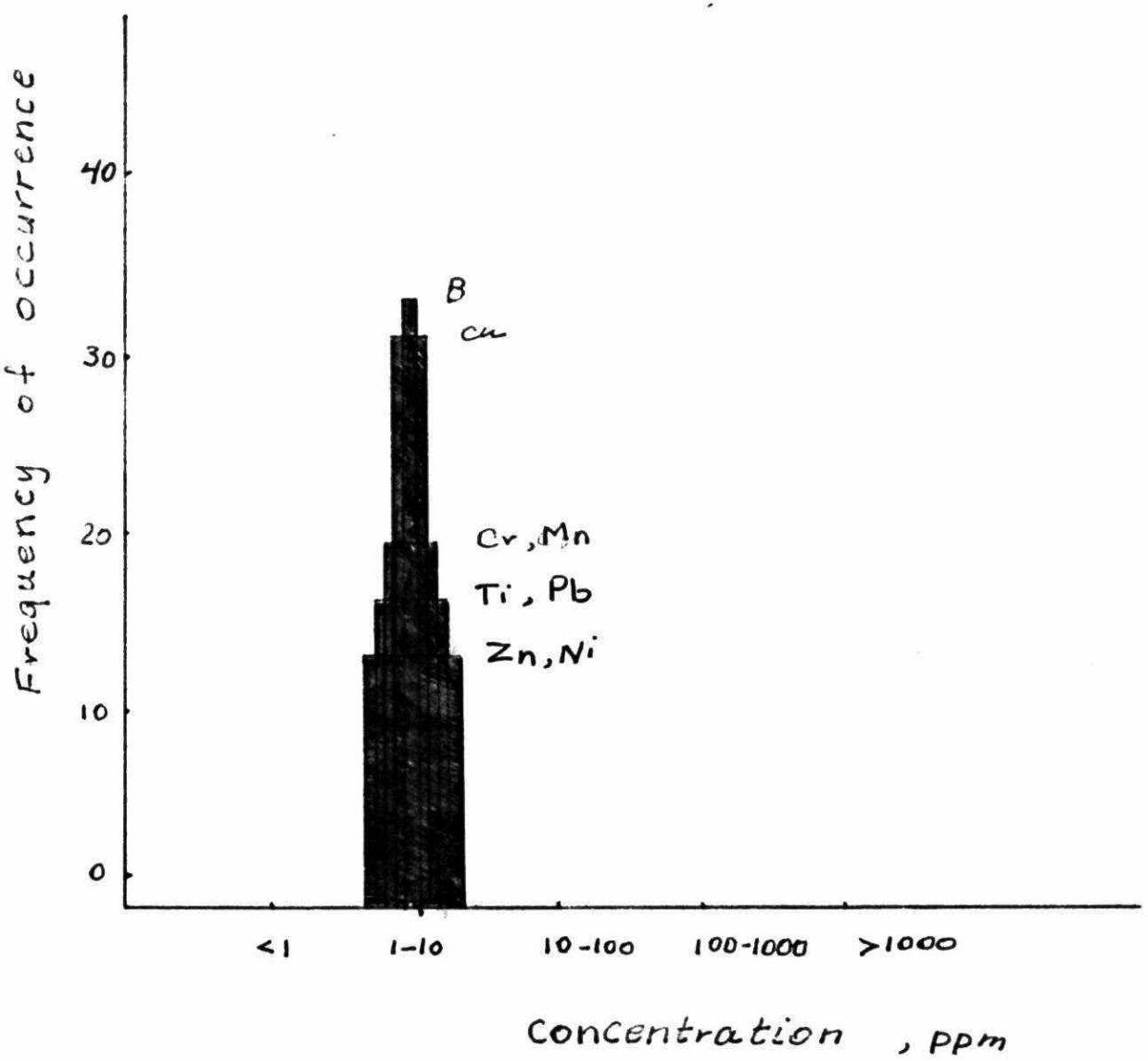
LSB NUMBER	SUBMITTED CLASS	PROPOSED CLASS	REASON	SAMPLE DESCRIPTION	PERTINENT ANALYSIS	SIGNIFICANT ANALYTICAL PARAMETERS
T41-2	106	101 + 103	acidic	green liquid with white particles	metals anions	high: Fe, Ni, PH 4.7, acidity 2500.
T41-3	103	101 + 103	acidic	green liquid with oil slick and residue	metals anions	high: Al, Fe, Mn, B, Pb, Ni, Cr. PH 0.7, acidity 191,000, chloride 23 00, sulphate 178,000.
T41-6	103	no change	no change	no change	metals	high: Fe, B. Sn, Cu, Ni, Co, Cr; unknown Zn.
T41-9	190	waste water or new class	waste water	black liquid with oil slick + ≃ 5% particles	metals anions	none.
T41-13	203	203 + 301	organic solvent + dye	reddish mobile liquid + 1 - 2% carbon	organics	Toluene and toluene soluble dye
T35-27	102	no change	no change	no change	metals	high: Fe, Pb, Cr; average Cu, Zn. Other parameters not reported
T42-32	202	no change	no change	oil waste	metals PCB organics	high: Al, Fe, Ca, Mg, Ti, Ba, Pb, Cu, Cr, AS; Interf. on Cd. No PCB. organics: no data.
T42-34	202	no change	no change	no change	metals PCB organics	high: Fe, Ca, Mg, low Mn, Pb, Cu, Cr, Ni. No PCB. organics: no data.

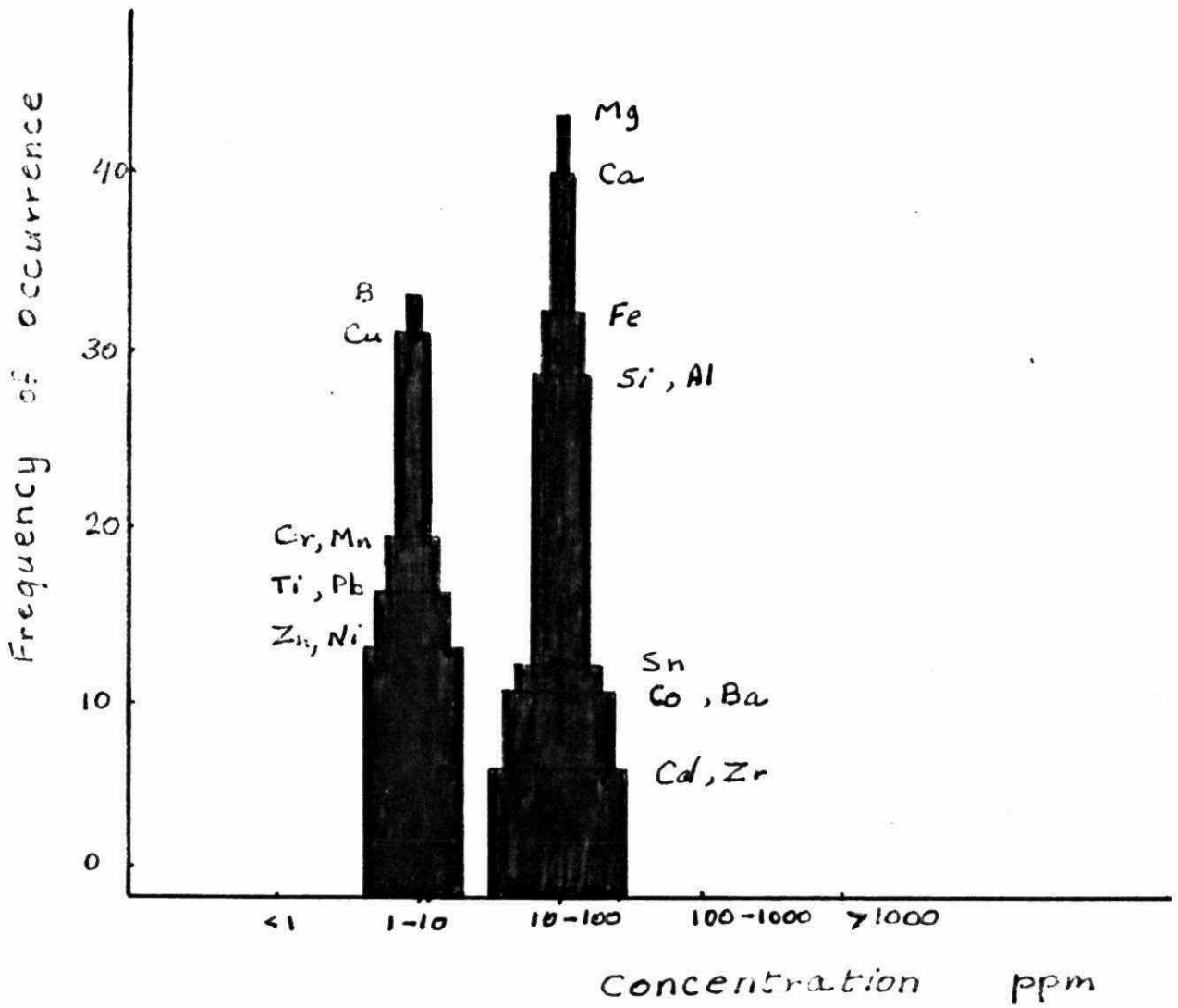
LSB NUMBER	SUBMITTED CLASS	PROPOSED CLASS	REASON	SAMPLE DESCRIPTION	PERTINENT ANALYSIS	SIGNIFICANT ANALYTICAL PARAMETERS
T42-35	202	no change	no change		metals organics	high: Fe, Ca, Mg, Sn, Cu, Cr, As, Sb; Interf. Cd and Hg. organics: no data.
T42-38	304	no change	no change		organics	no data.
T43-83	103	no change	no change		metals anions	high: Al, Fe, Ca, Mg, Zn, low Ti, Mn, B, Ni, Cr. Sulphate: 35,000.
T4-24	190	no change	no change	paint stripper	metals organics	Cr > 8ppm. other metals are low. organics: no data.
T41-1	290	401	animal waste	semiclear greyish liquid with solids	metals anions organics microbiology	low metals. PH 5.6, animal fat. for microbiology: see detailed data.

An attempt has been made to correlate the frequency of occurrence (number of samples) of heavy metals relative to their most frequently found concentration. The following figure shows the obtained geometrical distribution. It was noticed that the metals occurrence maxima coincide, and although different, can be grouped mainly in two concentration levels. The first group includes magnesium, calcium, iron, silicon, aluminum, tin, cobalt, barium, cadmium and zirconium at concentrations between 10 and 100 ppm. The second group includes boron, copper, chromium, manganese, titanium, lead, zinc and nickel at concentrations between 1 and 10 ppm. This does not mean that some of the samples could not contain high concentrations of one element or more or of significant levels of metals not encountered in the samples. It also does not necessarily imply that the presence of a high concentration of an element is accompanied by high concentrations of other metals. In order to use this proposition as an indicator for the occurrence and possible levels of metals more data would be required on specified classes of liquid wastes collected from certain industries. However, it is felt that such an approach is worth examining in subsequent samples as it could result in an extremely cost-effective indicator technique.

A similar approach should be attempted to establish some profile of organic compounds likely to be present in specified waste types.


Number of samples
40
30
20
10
0
Mg
Ca
Fe
Si, Al
Sn
Co, Ba
Cd, Zr
<1
1-10
10-100
100-1000
>1000
PPM
concentration


Frequency of occurrence
40
30
20
10
0
B
Cu
Cr, Mn
Ti, Pb
Zn, Ni
<1
1-10
10-100
100-1000
>1000
Concentration, ppm


Frequency of occurrence
40
30
20
10
0
Mg
Ca
Fe
Si , Al
B
Cu
Cr, Mn
Ti , Pb
Zn, Ni
Sn
Co , Ba
Cd, Zr
<1
1-10
10-100
100-1000
>1000
Concentration ppm

10. REVIEW OF THE EXISTING MOE WASTE CLASSIFICATION GUIDELINE

Apart from the above mentioned comments on the adequacy of classification relative to the chemical composition of wastes and the subsequent need for additional classification types to accurately describe the waste, many of the chemical agents classified under one type or another need to be reviewed. This review should, however, be accompanied by setting standards and criteria and the classification should be subject to review as need arises. Looking at classification 101 for Acids, one can notice the presence of carbonate waste, aluminum chloride, acetic acid, formic acid and even fatty acids in the same classification together with sulphuric, hydrochloric and other mineral acids. This one classification can be easily and more meaningfully divided into four types i.e. mineral acids, acidic mixtures, acidic salt solutions,and organic acids. Also classification 201 designated for oily water is not suitable for oil and varsol since varsol is already classified as an organic solvent in #203. Aromatic hydrocarbons are not specified in #203. Classification #205 refers to polymerstyrene and polystyrene as separate compounds while they are essentially the same. Also Styrene Acrylonitile is not (ABS) but is SAN, ABS is Acrylonitrile Butadiene Styrene. Methyl Methacrylate should be referred to as Poly-Methyl Methacrylate and "rubber" be added to "isoprene". Classification #206 seems to be ambiguous with reference to amide, MEA and DEA. The classification should refer to both the technical and commercial name of the listed individual or mixture of compounds. This same comment applies to "TDI Residue" (Toluene di-isocyanate) which is improperly listed as a phenol in #208.

"Wax and Water" can hardly be classified under #301 designated for pigments, paints, printing and adhesives. In fact, the components of this classification are contradictory in terms of composition. For example, "Waste Ink" is incompatible with "Wax and Water" and neither is compatible with "Rubber Cement" or "Paint Sludge". Waste classification #304 designed for "Pharmaceutical and Cosmetics" does not refer to any waste at all. Furthermore, "Starch" is improperly classified under "Inert Sludge" #402 in the same category with "Portland Cement". Classification #401 is certainly more appropriate. Titanium is a metal and cannot be included under "Inert Sludge". Classifications #190 and #290 designed for "Other Inorganics" and "Other Organics" would not be required if a more precise classification cystem was established.

Other environmental contaminants such as "Asbestos" and asbestos containing wastes are not referred to in the Guideline.

Wastes which are prone to fire hazards or immediate acute toxicity should have a separate classification number with a special warning of the hazard.

11. IMPACT OF WASTE CLASSIFICATION ON WAYBILL-MANIFEST SYSTEMS

The problems associated with the classification, transportation, disposal of liquid industrial wastes and their regulations through manifest systems are not unique to Ontario. In December 1980, the Environment Council of Alberta has released an extensive report on Hazardous Waste Management in Alberta. Other reports on the subject include the regulations that emerge from the Resources Conservation and Recovery Act in the United States. The manifest system has also been successfully used in several European countries. For example, the Federal West German manifest system includes 35 broad classification categories of wastes. Here in Canada, the Federal Government passed the Transportation of Dangerous Goods Act in July 1980 to serve as a model for provincial waste handling standards.

In this respect, it is interesting to comment on the ongoing activities in Alberta. Their classification is based on the effects of toxic and hazardous substances rather than listing of various chemical/biological agents in groups with some compromise made to their common hazardous effects. This results in a limited number of waste classifications: radioactive, explosive, ignitable, toxic, reactive, corrosive, infectious, sensitizer, bioaccumulative, mutagenic-carcinogenic as well as a miscellaneous group for those classes not covered by the above types. The primary objectives of Alberta's manifest system can be summarized as:

1. Use of data to determine the type, quantity, and location of generated and disposed of wastes;
2. Control of illicit dumping of hazardous wastes;
3. Safe handling and control of wastes;
4. To assist enforcement agencies in identifying problem areas.

Here in Ontario, the waybill system was first introduced in 1977 and reviewed in 1979. The degree of its success would be closely related to the effectiveness of the waste classification.

On the basis of the data obtained on the chemical/biological characterization of various types of wastes, one can easily select the present classification Guideline as a prime candidate for review. The development of a more specific waste classification will not only improve the performance of the waybill system, but will also make it more acceptable to industrial generators, transporters and receivers of wastes. In addition, public perception will be improved as it sees the enforcement agencies in control of management of industrial wastes.

12. RECENT LIQUID INDUSTRIAL WASTE PROJECT - (CCOLW)

The Laboratory Branch and Central Region were recently involved in the chemical characterization of oil-organic liquid waste samples representative of approximately 360 drums that were located in Continental Co. Warehouse. Since the waste was intended to be disposed of, the Central Region has requested full characterization of organic compounds, metals and the presence or absence of PCB's. The submitted samples were not classified according to the Classification Guideline and were not intended to be a part of the CHLIW program. However, the problem was dealt with in the Laboratory as an example of the chemical characterization of liquid wastes, at least from the analytical point of view. The obtained data is felt to be germane to the matter of CHLIW information and is included in the Appendix to this report. Some of the conclusions made in this report underline and support those of the CHLIW work.

13. RECOMMENDATIONS

1. A priority pollutants list should be developed to include hazardous, toxic and dangerous chemical agents.
2. Criteria for chemical, physical and biological detrimental effects of pollutants and dangerous materials on the total environment and health should be specified with consideration given to:

   Priority pollutants list, radioactivity, explosive and ignitable nature, reactivity, corrosivity, infectious and bio-accumulative properties, toxicity, carcinogenicity, mutagenicity and teratogenicity of the wastes.
3. The developed criteria should be specific to each type of liquid waste with the concentration, activity, fugacity or any other measurement scale made specific to the contaminant in the waste and its availability to the total environment. Once the measurement scale is specified, the means of measurement, analysis, etc. should be adjusted accordingly.
4. A new modified waste Classification Guideline should be developed with consideration given to the above three topics. The new guideline should be comprehensive, specific to waste types and their composition, yet it must be clearly understandable to waste generators, transporters and MOE field staff.
5. The waybill system should be adjusted to accommodate the above.
6. Since the sampling of such complex waste materials is an integral part of the analysis, sampling procedures should be studied and recommendations be made on the suitability of sampling techniques parallel to the waste type.

7. A scheme for laboratory analysis of industrial wastes should be developed to efficiently provide meaningful data. This scheme goes beyond the scope of this report and will not be detailed here. The arrangements made with the existing laboratory framework to cope with most of the samples taken in the project were suitable to the task but indicate a need for a functioning industrial waste laboratory. The proposed laboratory, can be the basis for a hazardous contaminants laboratory which can be developed based on an open laboratory concept.

8. Directives should be developed for the segregation of wastes generated at the source. This would be in the interest of the generators and facilitate economic disposal practices.

14. SUGGESTED FUTURE STUDIES

1. One of the most important steps toward a complete management of industrial wastes in Ontario is to have an accurate inventory of contaminants in various types of liquid waste materials. This can be achieved by characterization of all classified wastes on the basis of the geographical location of their generation and disposal of through Regional Industrial Abatement Offices. The data base from all regions should be centralized in the Waste Management Branch and should be retrievable by regional staff.

2. Since most of the workload generated by the Special Investigation Units in each region will mainly be related to industrial waste discharges, samples collected should be considered as part of the spot tests described above.

3. A system should be worked out for fast screening of suspected waste materials for radioactivity. This system should specifiy the protocol that should be followed if measurable levels of radioactivity are detected.

4. Since a significant portion of both treated and non-treated wastes might end up by being disposed of on land, solidified or dumped in deserted mines, studies on the environmental fate of various chemical agents would be recommended. Leaching efficiency, volatilization, vapour emission, transport by biological agents, etc. should be related to the actual levels of contaminants in the original waste materials. Adjustments in the criteria should be made if required.

   Good candidate sites for this study would be Beare Road and Twin Lakes TWP (Sarnia) previous landfill areas.

5. One of the problems which was felt during this work was the uncertainty, and in many cases the unavailability of definite data on the toxicity of the detected contaminants. Studies should be encouraged to establish toxicity criteria and to relate them to waste types.

6. Studies should be intensified to assess the degree of contamination of soils and well water in sites previously used for disposal of liquid industrial wastes.

7. The responsibility for a full characterization of the waste should be clarified. In the event that analyses of batches of liquid industrial waste become the responsibility of the generator, an inventory of the analytical data should be available to the Ministry of the Environment Field staff for inspection. Spot sampling and analyses should be performed to confirm the validity of the waste generators inventory data.

8. For a proper characterization of the spot test waste samples, sample analysis should be performed in two stages.

   (a) Field analysis where M.O.E., staff supplied with portable fast testing equipment should describe the colour, odour, and other physical tests, radioactivity if suspected, estimates of pH, quantity, rate of generation or flow of wastes... etc.

   (b) Laboratory analyses start by comparing the field information to laboratory preliminary tests. Analyses should be performed first to confirm the levels of pollutants described in the classification of the waste followed by other diagnostic analyses to clear the possibility of presence of contaminants that are not accounted for.

9. If the Waybill information is to be stored in a data base system, the analytical results obtained on the spot samples should be marked to provide a reference to both preceding and following Waybill information collated from the same generator. Adjustments should be made to liquid waste haulers as a warning light before mixing of contradicting chemical agents.
10. Since the disposal, destruction and the elimination of environmental hazards is the ultimate goal, all possible information obtained and/or suspected to be a significant part of the waste should be passed on to the staff responsible for disposal of wastes. In addition to the above "commandments", operation of the overall system i.e. Waybill, classification, analysis, disposal...etc. should be reviewed annually and adjustments be made whenever necessary.

APPENDIX

Ontario

Ministry of the Environment

Laboratory Services Branch
Resources Road, Rexdale

MEMORANDUM: February 4, 1981

TO: Mr. D. Bartkiw
Central Region
150 Ferrand Drive
Don Mills, Ontario

FROM: Dr. M. Moselhy
Supervisor, Industrial Wastes
ITC, Laboratory Services Branch

RE: CHARACTERIZATION OF CONTINENTAL OIL LIQUID WASTES

This refers to the oil liquid waste samples (20) collected by the Central Region as representative of the liquid waste contained in the 390 drums discovered in the Continental company warehouse on 20 Norseman Street, Etobicoke. The samples were received in the Laboratory on November 18 and 19th, 1980. As you requested the samples were immediately submitted to Inorganic Trace Contaminants, Organic Trace Contaminants and Pesticides Sections accompanied with a request for giving these analyses a high priority. Identification of hazardous chemical agents in these samples required the attention of three sections in the Laboratory: Pesticides Section for PCB's, Organic Trace Contaminants Section for organics and Inorganic Trace Contaminants Section for heavy metals.

1 - PCB:

None of the analyzed samples showed the presence of PCB's with the exception of sample your #8, Laboratory #T47-29 which shows the presence of PCB at the level of 6 ppm. The presence and/or absence of PCB's was based on a detection limit of 5 ppm in oil-like samples and the samples were analyzed according to the accepted routine method. The presence of only 6 ppm of PCB in only one sample when the rest were reported as <5 ppm might not suggest that the material is contaminated with PCB or its absence and does not permit the differentiation between the two waste types, nor does it address the possibility of the absence of PCB's in the remaining drums.

2 - Characterization of organic compounds:

Laboratory investigation in Organic Trace Contaminants involved density measurements, determination of percentage volatile components, gas chromatographic characterization of volatile aromatic hydrocarbons and infra-red spectrophotometric analysis of the volatile and non-volatile fractions. The Organic Trace Contaminants Section classified the samples in three major groups based on the similarity of sample composition:

Group A - 11 samples

These consisted of basically high boiling petroleum hydrocarbons of paraffinic and naphthenic nature with a small quantity of aromatic compounds, carbon black and elastomers. Most samples showed not to contain significant quantities of volatile hydrocarbons. The relative ratios of oil: carbon black: elastomer varied somewhat from sample to sample. Thus these samples can be considered identical for waste classification purposes.

Samples in Group A:

Sender's Number	Lab. Number	
2	T47-23	0-110-2825
7	T47-28	0-110-2830
8	T47-29	0-110-2831
10	T47-31	0-110-2833
12	T47-33	0-110-2835
14	T47-35	0-110-2837
15	T47-49	0-110-2838
16	T47-50	0-110-2839
17	T47-51	0-110-2840
18	T47-52	0-110-2841
19	T47-53	0-110-2842

Group B - 6 samples

Group B samples consisted mainly (82 - 95%) of toluene. The non-volatile residue contained carbon black and elastomers (natural and/or synthetic rubber).

Samples in Group B:

Samplers' Numbers	Laboratory Numbers	
3	T47-24	0-110-2826
4	T47-25	0-110-2827
5	T47-26	0-110-2828
6	T47-27	0-110-2829
9	T47-30	0-110-2832
11	T47-32	0-110-2834

Group C - Miscellaneous

Sender's Number 1: Lab. No's. T47-22; 0-110-2824 consisted of apparently rain water (pH 6.5, TOC 6 ppm, conductivity: 48).

Sender's Number 13: Lab. No's. T-47-34; 0-110-2836 was shown

to be a mixture of high boiling petroleum hydrocarbons and phthalate ester plasticizer, mainly dioctyl phthalate 44% as shown by gas chromatography.

Sender's Number 20: Lab. No's. T-47-54; 0-110-2843. This sample consisted of approximately 90% (w/w) toluene and 10% of carbon black, elastomers and organosilicaone compounds.

3 - Determination of heavy metals:

Analyses of the Continental Oil waste samples for heavy metals were carried out in the Inorganic Trace Contaminants Section using emission spectrography and D.C. arc excitation. Since the technique used requires that the samples be in the powder form, known portions were ignited and the residues were analyzed after their mixing with buffer-carriers. A quick look at the data reveals that the Si, Al, Pb, Zn, (Fe, Ca and Mg) levels were relatively high and varied from one sample to another. Low levels of Ti, Ba, Sn, Cu, Ni, Cr and Co were also detected in some of the samples. Although the heavy metals data can only be used for qualitative purposes, they are in support of the classification of the waste material as suggested by the organic results: the high boiling petroleum hydrocarbon waste samples roughly follow the pattern of high levels of Si, Al, Pb and Zn.

The remaining metals in the scan do not permit characterization based on the available qualitative low level data: low ppm for Ti, Ba, Cu, Ni and Co; average ppm for Fe, Ca and Mg; <0.8 to <8 for Be, Ge, Tl, Ga, Bi, V, Mo, Ag, In, Zr, As, Sr, Cd, B, Sb, Sn and Cr; and <8 to <80 for mercury. The fact that "less than ,<," concentrations were reported does not imply neither the presence or absence of the metal at that range nor the impossibility of loss of some of the metal content during the ignition of samples.

On the other hand, if we consider lead and zinc to be the most two hazardous metals identified in these wastes the results can be summarized in the following tables (1), (2) and (3) for groups A, B and C classified by Organic Trace Contaminants.

Table (1): Group A samples

Sender's Number	2	7	8	10	12	14	15	16	17	18	19
Pb	<0.8	>80	>80	8-24	8-24	≈80	>80	24-80	24-80	0.8-2.4	≈0.8
Zn	2.4-8	>80	>80	<2.4	>80	≈80	>80	>80	>80	8-24	≈2.4

Table (2): Group B samples

Sender's Number	3	4	5	6	9	11
Pb	≈8	<0.8	<8	<8	≈80	≈8
Zn	*	*	>800	>800	24-80	8-24

* no results available

Table (3): Group C samples

Sender's Number	1	13	20
Pb	≈2.4	<0.8	≥80
Zn	<2.4	2.4-8	>80

Table 4

Heavy metals: Qualitative analysis of ignited samples by D.C. Arc

Lab #	Sender's#	Si	Al	Fe	Ca	Mg	Ti	Ba	Pb	Sn	Cu	Ni	Cr	Co	Zn
47 23	2	0.8 2.4	--	≈0.8	≈0.8	--	--	--	T <0.8	T <0.8	--	--	--	--	2.4 8
28	7	≥400	80- 400	8- 24	8- 24	8- 24	8 24	2.4 8	>80	T <0.8	≈2.4	≈2.4	T <0.8	2.4 8	>80
29	8	24 80	≈80	2.4 8	8 - 24	8 24	≈0.8	≈2.4	>80	--	≈2.4	≈2.4	T <0.8	2.4 8	>80
31	10	≈80	2.4 8	8 24	2.4 8	0.8 2.4	T <0.8	--	8 24	T <0.8	≈2.4	--	--	--	<2.4
33	12	80 400	80 400	8 24	8 24	≈24	2.4 8	2.4 8	8 24	--	≈2.4	≈2.4	T <0.8	2.4 8	>80
35	14	80 400	≈80	2.4 8	8 24	0.8 2.4	≈8	T <0.8	≈80	--	T <0.8	2.4 8	T <0.8	2.4 8	≈80
49	15	80 400	≈80	8 24	8 24	8 24	≈8	--	>80	T <0.8	0.8 2.4	2.4 8	T <0.8	2.4 8	>80
50	16	80 400	80 400	2.4 8	8 24	8 24	2.4 8	8 24	24 80	T <0.8	T <0.8	0.8 2.4	T <0.8	0.8 2.4	>80
51	17	80 400	80 400	2.4 8	8 24	8 24	0.8 2.4	2.4 8	24 - 80	T <0.8	0.8 2.4	≈8	T <0.8	8 24	>80
52	18	0.8 2.4	2.4 8	2.4 8	0.8 2.4	T <0.8	--	--	0.8 2.4	T <0.8	2.4 8	--	T <0.8	--	8 - 24
53	19	0.8 2.4	2.4 8	≈2.4	0.8 2.4	T <0.8	<0.8	<0.8	≈0.8	T <0.8	2.4 8	<0.8	T <0.8	<0.8	≈2.4
24	3	80 400	2.4 8	2.4 8	80 400	80 400	<0.8	<0.8	≈8	<0.8	<0.8	0.4 0.8	<0.8	--	--
25	4	≈8	0.8 2.4	0.8 2.4	≈0.8	2.4 8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	--	--
26	5	800 4000	80 240	240 800	800 4000	800 4000	T <8.0	<8	T <8	T <8	8 24	T <8	≈8	8 24	>800
27	6	800 4000	80 240	80 240	800 4000	800 4000	T <8	<8	<8	≈8	≈8	T <8	≈8	8 24	>800
30	9	≈80	2.4 8	2.4 8	0.8 2.4	8 24	T <0.8	<0.8	≈80	T <0.8	≈0.8	<0.8	<0.8	<0.8	24 80
32	11	8 24	2.4 8	8 24	2.4 8	8 24	8 24	--	≈8	T <0.8	≈2.4	--	T <0.8	--	8 24
22	1	≈400	80 400	24 80	80 400	≈8	0.8 2.4	--	≈2.4	--	0.8 2.4	T <0.8	≈0.8	--	<2.4
34	13	0.8 2.4	2.4 8	2.4 8	0.8 2.4	2.4 8	--	--	T <0.8	--	T <0.8	T <0.8	--	--	2.4 8
54	20	≈400	24 80	8 24	≈8	8 24	8 24	--	≥80	T <0.8	0.8 2.4	T <0.8	T <0.8	--	>80

Results reported in ppm

The significant metal content identified in 18 samples is listed in table 4.

Table 5 shows all the identified chemical agents corresponding to the analyzed samples. Based on the organic results these samples can be classified as organic solvents #203 in the waste Classification Guidelines (December, 1978). However, the presence of relatively high concentrations of lead, zinc, silicon, aluminum and lower concentrations of other metals might suggest the addition of a new classification in the Guidelines for those organic liquid wastes which contain heavy metals. This is especially important since samples classified as organic wastes might not reach the hands of the inorganic analyst and consequently a possible hazard can easily be overlooked. This requires the revision of the Ministry of the Environment Classification Guidelines in order to cope with Policy # 4 - Hazardous substances (Ref. Water Management) which calls for:

1) Identification of potentially hazardous substances,
2) assessment of the impact of the substances,
3) control and regulation of the manufacture, processing, importing, use and disposal of the substances,
4) monitoring of the substances in the environment and analysis and interpretation of the monitoring data; and
5) establishment of environmental criteria, etc.

The policy of preventive measures adopted by the Ministry of the Environment should continue to be the backbone when dealing with such liquid industrial wastes.

Moselhy M.

Moselhy M. (Ph. D.)

MM:pp

cc. Mr. J. N. Bishop
Mr. G. C. Ronan
Dr. O. Meresz
Mr. G. A. V. Rees
Mr. D. Hogg

TABLE 5

On November 18 and 19, 1980, a total of twenty drums were sampled at the above waste holding facility by Mr. P. Lassio of the Central Region Industrial Abatement Section

	Si	Al	Fe	Ca	Mg	Ti	Mn	Ba	B	Pb	Sn	Cu	Ni	Cr	Cd	Co	Zn	Hg	As	Sr	Group
T47-23	0.8-2.4	<.8	=0.8	=0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	2.4-8	<8	<2.4	<2.4	
-28	>400	80 - 400	8 - 24	8 - 24	8 - 24	8 - 24	<0.8	2.4 8	<0.8	>80	<0.8	=2.4	=2.4	<0.8	<0.8	2.4 8	>80	<8	<2.4	<2.4	
-29	24 80	=80	2.4 8	8 - 24	8 - 24	=0.8	<0.8	=2.4	=2.4	>80	<0.8	=2.4	=2.4	<0.8	<0.8	2.4 8	>80	<8	<2.4	<2.4	
-31	=80	2.4-8.0	8.0-24	2.4 8	.8 - 2.4	<0.8	<0.8	<0.8	<0.8	8 - 24	<0.8	=2.4	<0.8	<0.8	<0.8	<0.8	<2.4	<8	<2.4	<2.4	
-33	80-400	80-400	8 24	8 - 24	=24	2.4 8	<.8	2.4-8	=0.8	8 - 24	<0.8	=2.4	=2.4	<0.8	<0.8	2.4-8	>80	<8	<2.4	<2.4	A
-35	80-400	=80	2.4-8	8 - 24	0.8-2.4	=8	<0.8	<0.8	<0.8	=80	<0.8	<0.8	2.4-8	<0.8	<0.8	2.4-8	=80	<8	<2.4	<2.4	
-49	80 400	=80	8 - 24	8 - 24	8 - 24	=8	<0.8	<0.8	=0.8	>80	<0.8	0.8 2.4	2.4-8	<0.8	<0.8	2.4-8	>80	<8	<2.4	<2,4	
-50	80-400	80-400	2.4-8	8 - 24	8 - 24	2.4-8	<0.8	8 - 24	=0.8	24 - 80	<0.8	<0.8	0.8-2.4	<0.8	<0.8	0.8 2.4	>80	<8	<2.4	<2.4	
-51	80-400	80-400	2.4 8	8 24	8 24	0.8 2.4	<0.8	2.4 8	0.8 2.4	24 - 80	<0.8	0.8 2.4	=8	<0.8	<0.8	8 - 24	>80	<8	<2.4	<2.4	
-52	0.8 2.4	2.4 8	2.4 8	0.8-2.4	<.8	<0.8	<0.8	<.8	<0.8	0.8 2.4	<0.8	2.4-8	<0.8	<0.8	<0.8	<0.8	8 - 24	<8	<2.4	<2.4	
-53	0.8 2.4	2.4 8	=2.4	0.8 2.4	<0.8	<0.8	<0.8	<0.8	<0.8	=0.8	<0.8	2.4 8	<0.8	<0.8	<0.8	<0.8	=2.4	<8	<2.4	<2.4	
-24	80 400	2.4 8	2.4 8	80 400	80 400	<0.8	<0.8	<0.8	=0.8	=8	<0.8	<0.8	0.4 0.8	<0.8	<0.8	--	--	<8	<2.4	<2.4	
-25	=8	0.8 2.4	0.8 2.4	=0.8	2.4 8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	--	--	<8	<2.4	<2.4	
-26	800 4000	80 240	240 800	800 4000	800 4000	<8	<8.0	<8	=8	<8	<8	8 24	<8	=8	<8	8 - 24	>800	<80	<24	<24	
-27	800 4000	80 240	80 240	800 4000	800 4000	<8	<8.0	<8	8 24	<8	=8	=8	<8	=8	<8	8 - 24	>800	<80	<24	<24	B
-30	=80	2.4 8	2.4 8	0.8 2.4	8 24	<0.8	<0.8	<0.8	<0.8	=80	<0.8	=0.8	<0.8	<0.8	<0.8	<0.8	24 80	<8	<2.4	<2.4	
-32	8 24	2.4 8	8 24	2.4 8	8 24	8 24	<0.8	<0.8	<0.8	=8	<0.8	=2.4	<0.8	<0.8	<0.8	<0.8	8 - 24	<8	<2.4	<2.4	
* -22	400	80 400	24 80	80 400	=8	0.8 2.4	<0.8	<0.8	<0.8	=2.4	<0.8	0.8 2.4	<0.8	=0.8	<0.8	<0.8	<2.4	<8	<2.4	<2.4	
-34	0.8 2.4	2.4 8	2.4 8	0.8 2.4	2.4 8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	2.4 8	<8	<2.4	<2.4	C
-54	=400	24 80	8 - 24	=8	8 - 24	8 - 24	<0.8	<0.8	<0.8	>80	<0.8	0.8 2.4	<0.8	<0.8	<0.8	<0.8	>80	<8	<2.4	<2.4	

* "Qualitative" Analysis performed on digested sample

** "Qualitative" Analysis performed on ignited sample by D.C. Arc

	Be,	Ge,	Tl,	Ga,	Bi,	V,	Mo,	Ag,	In,	Zr,	As,	Sr,	Hg,	Sb
Detection Limits	<0.8 <8	<0.8 <8	<0.8 <8	<0.8 <8	<0.8 <8	<0.8 <8	<0.8 <8	<0.8 <8	<0.8 <8	<0.8 <8	<2.4 <24	<2.4 <24	<8 <80	<0.8 <8

*** Detection Limit for PCB = 5 ppm.

**** The heavy metal data can only be used for identification purposes (Qualitative)

Organic Characterization

The samples, in 32 oz glass sample bottles, were submitted to the Laboratory for characterization. Laboratory investigation involved density measurements, determination of percentage volatile components, gas chromatographic characterization of volatile aromatic hydrocarbons and infrared spectrophotometric analysis of the volatile and non-volatile fractions. Tests for traces of PCBs and heavy metals will be reported by the Pesticides and ITC Sections, respectively.

Based on the analytical results, the wastes can be classified in three major groups:

Group A - 11 samples

These consisted of basically high boiling petroleum hydrocarbons of paraffinic and naphthenic nature with a small quantity of aromatic compounds, carbon black and elastomers. Most samples showed not to contain significant quantities of volatile hydrocarbons. The relative ratios of oil: carbon black: elastomer varied somewhat from sample to sample. Thus these samples can be considered identical for waste classification purposes.

Group B - samples

Group B samples consisted mainly (82 - 95%) of toluene. The non-volatile residue contained carbon black and elastomers (natural and/or synthetic rubber).

Sender's Number 1: Lab. No's. T-47-22; 0-110-2824 consisted of apparently rain water (pH 6.5, TOC 6 ppm, conductivity: 48).

Sender's No. 13: Lab. No's. T-47-34; 0-110-2836 was shown to be a mixture of high boiling petroleum hydrocarbons and phthalate ester plasticizer, mainly dioctyl phthalate 44% as shown by gas chromatography.

Sender's No. 20: Lab. No's. T-47-54; 0-110-2843. This sample consisted of approximately 90% (w/w) toluene and 10% of carbon black, elastomers and organosilicone compounds.

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